BULLETIN

OF THE

NEW HAMPSHIRE COLLEGE

Agricultural Experiment Station

1900-1901

NUMBERS 80 TO 87

AND

THIRTEENTH ANNUAL REPORT

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

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Bulletin 80 **January, 1901**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE
INSPECTION OF FERTILIZERS
IN 1900

IN COÖPERATION WITH THE STATE BOARD OF AGRICULTURE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS, 1900.

	Cents per pound.
Nitrogen in ammonia salts	17.0
" nitrates	13.5
" dry and fine ground fish, meat, and blood and in high grade mixed fertilizers	15.5
Nitrogen in fine ground bone and tankage	15.5
" medium ground bone and tankage	11.
Phosphoric acid soluble in water	4.5
" " " ammonium citrate (reverted)	4.
" " in fine ground bone and tankage	4.
" " in medium ground bone and tankage	4.
" " in coarse bone and tankage	3.
" " in fine ground fish, castor-pomace, and wood-ashes	4.
" " insoluble in mixed fertilizers	2.
Potash as sulphate free from chlorides and in wood ashes	5.
" " muriate	4.25

The above values are based on the wholesale market price for the materials, when sold in large lots at the principal trade centers in New England. The valuation of a ton of any mixed fertilizer based on the above figures will usually fall ten dollars below the retail price at the local agency. This variation includes such fixed charges as cost of mixing, bags, cartage and freight, salaries and commissions of agents, and interest. Nitrogen compounds cost more than in 1899; other materials were practically the same in price as in the previous year.

THE FERTILIZER INSPECTION IN 1900.

This year, as in the past, the New Hampshire College Agricultural Experiment Station has coöperated with the state board of agriculture in an inspection of the commercial fertilizers sold in the state.

In accordance with the public statutes, the collection of samples of the different fertilizers has been in charge of the secretary of the board of agriculture, Hon. N. J. Bachelder, who has been assisted by Mr. E. P. Jewett; while the chemical analyses have been performed under the direction of the chemist of the experiment station, Prof. Fred W. Morse, who has had for assistants Messrs. Roscoe H. Shaw and Harry A. Clark.

Under the present fertilizer law a manufacturer pays a license fee, which permits the sale of as many different brands of fertilizers as he may choose to place on the market. The multiplication of brands by the different makers has required more analyses than could be paid for out of the license fees, therefore several of the samples collected were not analyzed.

The list of brands not analyzed is published in order that all brands found by the agent of the board of agriculture may be included in this report, and that their guarantees may be compared by those farmers who may wish to select a fertilizer on the basis of its percentage composition.

COMPOSITION OF COMMERCIAL FERTILIZERS SAMPLED AND ANALYZED IN 1900.

MANUFACTURER AND BRAND.	Nitrogen.		Phosphoric Acid.							Potash.	
						Total.		Available.			
	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
ARMOUR FERTILIZER WORKS.											
Armour's All-Soluble Fertilizer	3.75	2 88	0.90	7.60	4.48	12.98	10.00	8.50	8.00	6.03	4.00
Armour's High Grade Potato Fertilizer	1.97	1.64	4.65	3.76	2.44	10.85	10.00	8.41	8.00	8.89	10.00
BOWKER FERTILIZER CO.											
The Dollar Brand Phosphate for all Crops	1.82	0.83	5.70	2.06	0.64	8.40	....	7.76	8.00	1.29	1.00
Bowker's Hill and Drill Phosphate	3.05	2.25	7.35	3.10	1.88	12.33	12.00	10.45	8.00	2.37	2.00
Bowker's Lawn and Garden Dressing	4.83	3.00	1.85	4.15	3 88	9.88	8.00	6.00	6.00	5.25	5.00
Bowker's Potash or Staple Phosphate	0.94	0.75	3.55	4.69	2.00	10.24	10.00	8.24	8.00	3.45	3.00
Star Special for Potatoes	2.09	1.65	4.95	2.81	1.00	8.76	....	7.76	7.00	3.07	3.00
The $25 Phosphate for All Crops	2.41	2.06	4.65	2.11	1.08	7.84	....	6.76	7.00	0.81	0.50
Stockbridge Complete Manure for Corn, Grain and Fodder Corn	3.66	3.00	4.05	2.69	3.28	10.02	10.00	6.74	8.00	7.42	7.00
Stockbridge Complete Manure for Onions	5.61	4.50	2.90	6.34	0.48	9.72	8.00	9.24	7.00	5.93	5.00
Stockbridge Complete Manure for Potatoes and Vegetables	3.87	3.24	5.75	2.81	2.04	10.60	8.00	8.56	6.00	9.97	10.00
Stockbridge Complete Manure for Vegetables and Potatoes	3.69	3.25	2.93	4.40	3.42	10.75	8.00	7.33	6.00	6.80	7.00
BRADLEY FERTILIZER COMPANY.											
Corn Phosphate	2.34	2.06	6.05	4.19	2.68	12.92	10.00	10.24	8 00	1.65	1.50
Complete Manure for Corn and Grain	3.89	3.30	5.40	6.40	2.64	14.44	13.00	11.80	12.00	2.65	3.00

Complete Manure for Potatoes and Vegetables	3.65	3.30	5.95	2.49	1.96	10.40	9.00	8.44	8.00	7.05	7.00
Complete Manure for Topdressing Grass and Grain	5.97	4.95	1.53	3.47	2.52	7.52	6.00	5.00	5 00	3.36	2.50
Potato Fertilizer	2 13	2.06	6.45	2.65	2.28	11.38	10 00	9 10	8.00	3.14	3 00
Bradley's Seeding Down Manure	2.97	2.50	6.70	2.91	1.88	11.49	12.00	9.61	7.00	2.39	2.00
CLARK'S COVE FERTILIZER COMPANY.											
Bay State Fertilizer	2.46	2.06	6.65	2.59	1.84	11.08	10.00	9.24	8.00	1.67	1.50
CLEVELAND DRYER CO.											
Cleveland Bone and Potash	......	.....	5.45	4.47	2.20	12.12	11.00	9.92	10.00	2.15	2.00
Cleveland Fertilizer	1 35	1 03	5.75	2.89	3.12	11.76	9 00	8.64	8.00	2.27	2 00
Cleveland Superphosphate	2.51	2.06	6.20	2.36	2.04	10.60	10.00	8.56	8.00	3.01	1.50
CROCKER FERTILIZER COMPANY.											
Potato, Hop, and Tobacco Phosphate	2.11	2 06	6.25	2.55	2.12	10.92	10.00	8.80	8.00	3.18	3.00
New Rival Ammoniated Superphosphate	1.81	1.03	6.60	2.44	2 08	11.12	9.00	9.04	8.00	2.05	2.00
CUMBERLAND BONE PHOSPHATE CO.											
Cumberland Guano	1.23	1.06	5.95	2.29	2.60	10.84	10.00	8.24	8.00	2 03	2.00
Cumberland Potato Fertilizer	1.75	2 06	6.45	2.03	2.44	10.92	10 00	8.48	8.00	2.80	3.00
E. FRANK COE CO.											
Celebrated Special Potato Fertilizer	2.13	1.50	7 70	1.30	1.84	10.84	10.25	9.00	8 00	3 43	4.00
Columbian Potato Fertilizer	1 38	1.20	6.30	2.61	3.64	12.55	9.00	8 91	8 50	2.56	2.50
Famous Grass and Grain Fertilizer	1.07	0.80	4.55	4.21	3.72	12.48	10.00	8.76	8 00	1.50	1.50
High Grade Ammoniated Bone Superphosphate	2.23	1.88	7.53	1.91	2.36	11.80	11.00	9.44	9.00	2.76	2.25
L. B. DARLING FERTILIZER CO.											
Darling's Bone, Blood and Potash	4.97	4.13	5.35	1.89	0.80	8.04	8.00	7.24	7.00	7.80	7.00
GREAT EASTERN FERTILIZER CO.											
Northern Corn Special	2.22	2.06	5.65	2.59	2.92	11 16	9 00	8.24	8.00	1.76	1 50
Potato Manure	2.22	2.06	6.30	2.77	2.45	11.52	9 00	9.07	8.00	3.00	3.25

COMPOSITION OF COMMERCIAL FERTILIZERS SAMPLED AND ANALYZED IN 1900.—*Continued.*

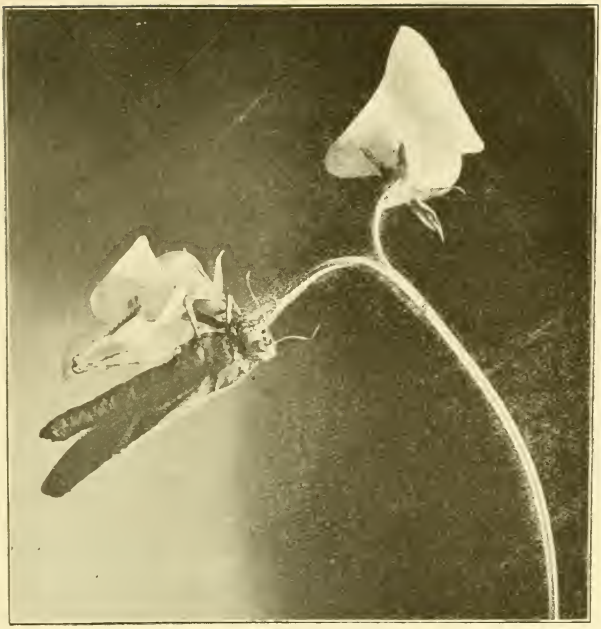
MANUFACTURER AND BRAND.	Nitrogen.		Phosphoric Acid.							Potash.	
						Total.		Available.			
	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
LISTER AGRICULTURAL CHEMICAL WORKS.											
Lister's Special Potato Fertilizer	1.90	1.65	6.15	2.93	2.76	11.84	9.00	9.08	8.00	3.23	3.00
Seeding Down Fertilizer	1.22	0.62	7.65	3.11	1.56	12.32	11.00	10.76	10.00	1.46	1.00
U. S. Superphosphate	1.26	1.32	6.00	3.38	3.14	12.52	8.00	9.38	7.00	2.27	2.00
LOWELL FERTILIZER CO.											
Swift's Animal Brand for all Crops	3.34	2.46	6.70	1.58	3.20	11.48	10.00	8.28	9.00	4.12	4.00
Swift's Bone Fertilizer for Corn and Grain	1.91	1.65	4.05	4.11	3.40	11.56	9.00	8.16	8.00	3.46	3.00
Ground Bone	2.46	2.47	......	......	......	28.40	23.00	......	......	......	......
Swift's Market Garden Manure	3.46	4.10	3.60	3.31	3.56	10.47	8.00	6.91	7.00	5.50	6.00
Swift's Potato Manure	2.18	1.64	3.90	3.26	3.36	10.52	8.00	7.16	7.00	4.44	4.00
PACIFIC GUANO CO.											
Potato Special	2.15	2.06	6.25	2.47	2.40	11.12	9.00	8.72	8.00	3.17	3.00
Soluble Pacific Guano	2.27	2.06	6.30	2.22	2.68	11.20	10.00	8.52	8.00	1.86	1.50
PACKER'S UNION FERTILIZER CO.											
Gardener's Complete Manure	2.93	2.47	2.50	3.38	2.32	8.20	8.00	5.88	6.00	9.81	10.00
Potato Manure	2.02	2.06	6.20	1.84	2.32	10.36	9.00	8.04	8.00	5.91	6.00
Wheat, Oats and Clover Fertilizer	......	......	6.35	3.09	2.32	11.76	12.00	9.44	11.00	2.03	2.00

PARMENTER & POLSEY.											
Special Potato Fertilizer	3.14	3.29	2.20	4.60	4.04	10.84	9.00	6.80	8.00	6.86	7.00
QUINNIPIAC COMPANY.											
Quinnipiac Corn Manure	2.36	2.06	3.85	4.07	2.28	10.20	10.00	7.92	8.00	1.50	1.50
Quinnipiac Potato Phosphate	2.14	2.05	6.25	1.78	2.72	10.75	9.00	8.03	8.00	2.82	3.00
READ FERTILIZER CO.											
Farmer's Friend Superphosphate	2.18	2.10	6.70	2.66	2.44	11.80	9 00	9.36	8.00	3.40	3.00
Potato Manure	3.25	2.47	3.80	3.30	2.68	9.78	7.00	7.10	6.00	9.63	10.00
Sampson Fertilizer	2.28	2.10	7.15	1.59	3.16	11.90	9.00	8.74	8.00	3.51	3.00
RUSSIA CEMENT CO.											
Essex Complete Manure for Potatoes, Roots, and Vegetables	4.37	3.70	5.40	3.54	4.08	13.02	9.00	8.94	7.00	8.23	8.50
Essex Potato Fertilizer	2.16	2.00	6.25	6.77	2.20	15.22	11.00	13.02	9.00	5.24	5.00
STANDARD FERTILIZER CO.											
Standard Special for Potatoes	1.98	2.05	5.30	2.94	2.48	10.72	9.00	8.24	8.00	3.22	3.00
HENRY F. TUCKER CO.											
Tucker's Original Bay State Bone Superphosphate	2.28	2 06	6.85	1.05	2 32	10.22	10.00	7.90	8.00	2.06	1.50
Tucker's Special Potato Fertilizer	1.96	2 06	6.15	2.57	2.44	11.16	10.00	8.72	8.00	3.61	3.00
WILLIAMS & CLARK FERTILIZER CO.											
Americus Potato Manure	2.06	2 06	5.65	2 95	2.44	11.04	9.00	8.60	8.00	3.05	3 00
Prolific Crop Producer	1.36	0.82	5.85	3 03	2.48	11.36	8.00	8.88	7.00	2.44	1.00
Ammoniated Bone Superphosphate	3.05	2.47	6.75	2.65	1.76	11.16	10.00	9.40	9.00	2.77	2 00

GUARANTEED COMPOSITION OF FERTILIZERS SAMPLED BUT NOT ANALYZED, 1900.

MANUFACTURER AND BRAND.	Nitrogen.	Phosphoric Acid.		Potash.
		Total.	Available.	
Armour's Ammoniated Bone with Potash.	2.47	8.00	6.00	2.00
Armour's Grain Grower	1.65	0.00	8.00	2.00
Bowker's Corn Phosphate	1.50	10.00	8.00	2.00
Bowker's Potash Bone	0.75	8.00	6.00	2.00
Bowker's Potato and Vegetable Phosphate	1.50	11.00	9.00	2.00
Bowker's Square Brand Bone and Potash.	1.50	12.00	6.00	2.00
Bowker's Sure Crop Phosphate	0.75	11.00	9.00	2.00
Stockbridge Manure for Celery	4.00	5.00	4.00	5.50
Stockbridge Manure for Strawberries	2.25	7.00	6.00	4.00
Bradley's Eclipse Phosphate	1.03	9.00	8.00	2.00
Bradley's English Lawn Fertilizer	4.95	6.00	5.00	2.50
Bradley's Potato Manure	2.50	8.00	6.00	5.00
Bradley's X. L. Superphosphate	2.50	11.00	9.00	2.00
Clark's Cove Potato Fertilizer	2.06	9.00	8.00	3.00
Cleveland Potato Phosphate	2.05	10.00	8.00	3.00
Crocker's Ammoniated Corn Phosphate	2.06	10.00	8.00	1.50
Cumberland Superphosphate	2.06	10.00	8.00	1.50
E. F. Coe's Columbian Corn Fertilizer	1.20	9.50	8.50	2.50
E. F. Coe's XXV Ammoniated Bone Superphosphate	0.80	9.00	8.00	1.50
Lister's Success Fertilizer	1.24	11.50	9.50	2.00
Swift's Potato Phosphate	2.47	9.00	8.00	6.00
Packer's Union Animal Corn Fertilizer	2.47	10.00	9.00	2.00
Packer's Union Universal Fertilizer	0.82	9.00	8.00	4.00
Parmenter & Polsey Plymouth Rock Brand	2.47	9.00	8.00	4.00
Read's Practical Potato Special	0.83	5.00	4.00	8.00
Read's Vegetable and Vine Fertilizer	2.10	9.00	8.00	6.00
Essex XXX Fish and Potash	2.10	12.00	9.00	2.25
Standard Fertilizer	2.06	10.00	8.00	1.50
Tucker's Imperial Bone Superphosphate	1.03	9.00	8.00	2.00

FRED W. MORSE, *Chemist.*



Grasshopper killed by Fungus Disease.

INSECT RECORD FOR 1900

BY CLARENCE M. WEED

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION
DURHAM

Bulletin 81 **February, 1901**

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

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THE INSECT RECORD FOR 1900

BY CLARENCE M. WEED

The most notable occurrence among the injurious insects of New Hampshire during the season of 1900 was the sudden disappearance of the hordes of Forest Tent Caterpillars[1] that for several previous seasons had been so destructive. This disappearance was so general and complete that it seems to me it is only to be accounted for satisfactorily on the supposition that it was due to unfavorable weather conditions. And as there is good evidence to show that the caterpillars hatched from the eggs in great numbers and began feeding in apparent health, it seems necessary to conclude that they were chiefly destroyed by the unusual and severe frosts that occurred early in May.

The positive evidence upon which I base this conclusion is chiefly derived from observations at Claremont, New Hampshire. My assistant, Mr. W. F. Fiske, visited this locality, May 1 and 2, 1900, and found that the caterpillars had hatched from the eggs in abundance. They were probably not quite so numerous as they had been a year before, but they were in sufficient numbers to do great damage had they matured. But they disappeared without doing any noticeable injury. On May 11th, there was a very severe and widespread frost, the temperature at Claremont going down to 16° F. and the ground being frozen to a depth of half an inch, as I learn from Mr. F. H. Foster. It seems to me probable that this remarkable freeze killed the caterpillars.

---

[1] *Clisiocampa disstria* Harris

Throughout this state and Vermont the same conditions seem to have prevailed. There have been no complaints of injury by the Forest Tent Caterpillars, while in many localities there have been expressions of surprise at their disappearance.

At Claremont, Mr. Fiske noticed that the young caterpillars which had hatched somewhat before the leaves unfolded were eating holes through the outer scales of the buds in order to get at the green and succulent tissues within. This might become a very destructive phase of the attack of this insect were it to become a fixed habit with the species.

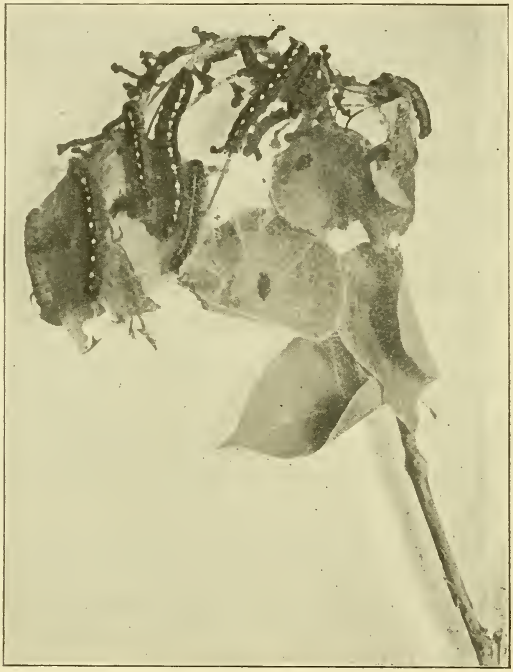

FIG. 2.—Moulting Tent of Forest Tent Caterpillar.

Another sudden disappearance was that of the SPINY ELM CATERPILLAR[1] treated of in BULLETIN 67. In 1899 this insect was so abundant as to do a very noticeable injury, but in 1900 practically no damage was done. It is hardly probable that the causes of disappearance were the same as those of the Forest Tent Caterpillar, because the life histories of the two insects are so different. Parasites were probably in part at least responsible in this case. Early in May I saw an Antiopa Butterfly depositing her eggs upon the willow twig shown in Fig. 3. As soon as she flew away I saw a tiny fly running about over the eggs, and watched it as it deposited its own eggs in those of the butterfly. This fly was a parasite; the eggs it deposited would hatch into little grubs that would develop at the expense of the butterfly eggs, preventing them from hatching. In half an hour the little parasite[1] laid her eggs in fifteen of those of the butterfly.

---

[1] *Vanessa antiopa* Linné.

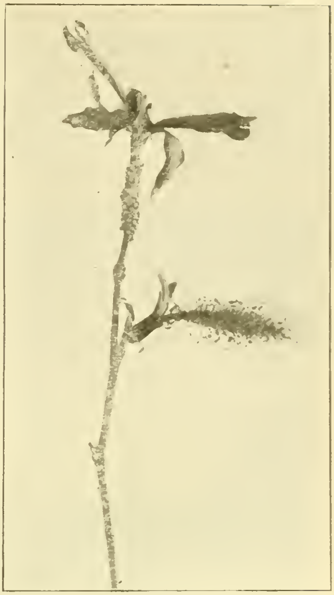

FIG. 3.—Eggs of Antiopa Butterfly on Willow Twig.

Another observation upon the enemies of this species seems worth recording. While driving along a country road late in May, I saw a Maryland Yellow-throat carrying an Antiopa Butterfly. The butterfly was dropped by the bird when disturbed and is shown in Fig. 4, the pieces broken off the wings probably indicating where the bird had caught it.

THE AMERICAN TENT CATERPILLAR[2] was rather more numerous than last year, though not at all abundant. Apparently the species is slowly increasing, and it is likely to continue so to do for several years, until it becomes so numerous as to do serious damage. As I wrote in last year's INSECT RECORD, the best time to fight the pest is during these years

[1] Since determined by Dr. L. O. Howard to be *Telenomus graptæ*.

[2] *Clisiocampa americana* Harris.

of comparative scarcity. Every colony destroyed now means as much as the destruction of a hundred colonies ten years hence.

During the latter part of May (the 24th) there was a severe hailstorm in southeastern New Hampshire, and I was particularly interested in its effect upon the tent caterpillar nests. Nearly all of these were riddled by the hailstones, many of them reduced to mere shreds, though more were left in the condition shown in Fig. 5, with great holes through the tents. The caterpillars at this time were so nearly full grown that comparatively few of the tents were repaired. It is probable that many of the pests were killed by the hailstones.

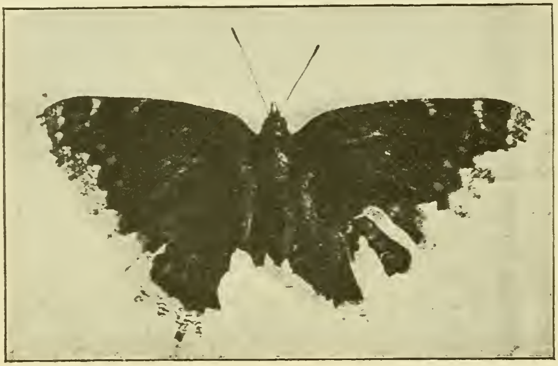

FIG. 4.—Antiopa Butterfly after being caught by Maryland Yellow-throat.

The TARNISHED PLANT BUG[1] has long been known as a troublesome pest upon a considerable variety of crop plants. It was reported to me this season in what appears to be an unrecorded attack. From Lebanon early in August came a complaint that this insect was proving very destructive to sweet peas. The bugs suck the juice from the flower stalk generally just below the bud, causing the latter to wither and die. Probably the most effective remedy would be to brush the pests off into shallow pans wet with kerosene. This had best be done early in the morning when the air is so cool that the insects are more sluggish than during the heat of the day.

[1] *Lygus pratensis* Linné.

In May the IMPORTED CURRANT BORER[1] was found to be abundant in currant bushes at Durham. This is a small whitish larva that burrows up and down the stems of currants, weakening them so that they are checked in growth, and appear stunted and unhealthy. The borer hatches from eggs deposited singly on the young stems near the buds, early in summer, by a beautiful, clear-winged, wasp-like moth, with a bluish black body, and three golden yellow transverse bands across the abdomen. The egg hatches a few days after it is laid into a small larva that gnaws through the stem to the center, where it feeds on the pith. It continues so to do all summer, making a burrow several inches long. When full grown the larva eats nearly through the stem wall, leaving only the membranous outer bark, and changes to a chrysalis within the burrow. When the chrysalis is ready to transform it wriggles partially out of this opening, bursting through the thin bark. It then rests half way out, its skin splits open in front, and the moth crawls out, leaving a mere shell behind. The moth expands and dries its wings, and then flies away. In southern New Hampshire these moths appear early in June, the specimens under observation coming out from June 6 to 10. There is but one brood a year. The best rem-

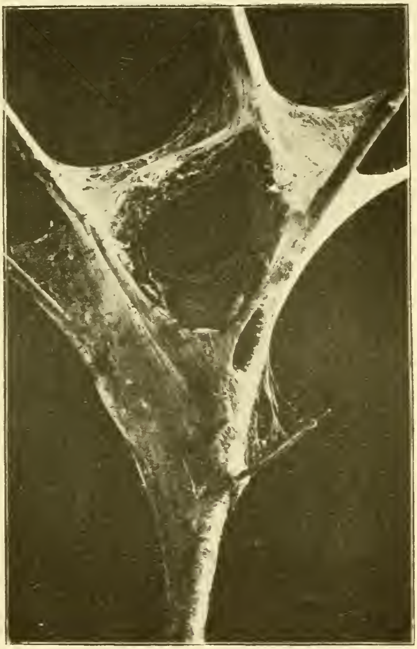

FIG 5.—Nest of Tent Caterpillar riddled by Hail.

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[1] *Sesia tipuliformis* Linné.

edy is to cut and burn the infested stems in spring before the first of June. On the infested stems the leaves are more backward in unfolding than on healthy ones.

The weather during this season, as well as during those immediately preceding, has been unusually favorable to the development of LOCUSTS or GRASSHOPPERS, which in several sections of the state, especially in river valleys, have done considerable damage. In the vicinity of West Concord they were so abundant that they were collected for the bounty of one dollar a bushel, authorized by the state law. The species most abundant at West Concord, as determined by collections made July 23, 1900, was the ATLANIS LOCUST.[1]

A noticeable feature of the unusual abundance of grasshoppers was the prevalence of a fungus disease that destroyed many of them. The diseased ones seen were chiefly of one species, the common Carolina Locust,[2] which was very plentiful during the summer. This insect is especially common along roadsides, and in open pastures and other grasslands. It is the one that most commonly flies up as one walks along a country road. At such times it flies rapidly in a zigzag manner for a rod or two before alighting.

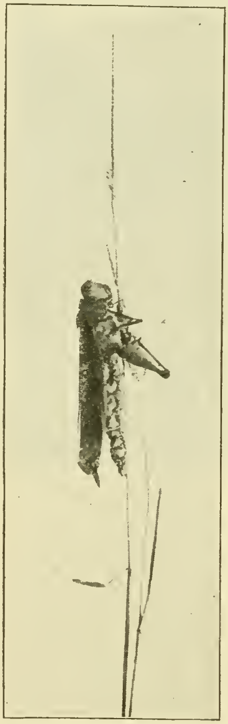

FIG. 6.— Carolina Locust killed by Fungus Disease.

The disease is caused by a parasitic plant that invades the tissues of the grasshopper, growing inside its body in such a way as to replace the internal organs. The insects thus affected seem impelled to climb up as high in the world as they can get and so they are found on the bark of trees, the sides of buildings, the stems of weeds and grasses and in other similar situations. Sometimes they will reach a position eight or ten feet from the ground. One was found clinging to the white petals of a beautiful sweet pea blossom; a photograph of it is shown on the title page to this bulletin. The dead grasshoppers become mummified and remain in position until they are broken up by wind and weather.

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[1] *Melanoplus atlanis* Riley.
[2] *Dissosteira carolina* Linné.

In previous bulletins some account has been given of the life history of the CHOKE CHERRY TENT-MAKER[1] which for several years has been very abundant along the roadsides where choke cherry bushes grow. The situation in which the eggs are laid has not, however, heretofore been known. Last spring I found that they are laid on the bark of the food-plant very near the ground. The flattened masses are at first of a yellow color, but they soon become brown and so closely resemble the bark that it is difficult to distinguish them. There is but one brood of larvæ each year; the eggs laid in summer remaining unhatched until the following spring. Then the young larvæ crawl to the top of the bush, where they construct a tent by sewing together the terminal leaves. One of these early tents is illustrated in Fig. 7. We also bred great numbers of parasites from these insects this season.

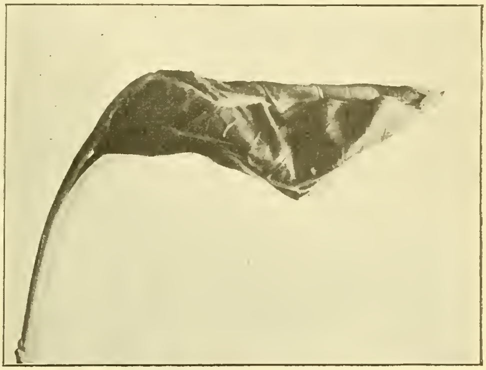

FIG. 7.—Early Tent of Choke Cherry Tent-Maker.

An extraordinary and widespread attack was made during the summer upon the leaves of birch trees throughout the state. A great many people noticed that the foliage of these trees was seared and brown long before the proper time, and if they looked at all closely they saw that each leaf was largely denuded of the green surface materials so that it showed the network of veins. Here and there upon the leaves one could also see small white specks which through a lens looked like bits of fine spun silk. The author of all this injury was a tiny caterpillar, so minute as commonly to be overlooked. It has been called the BIRCH LEAF BUCCULATRIX[1] from the name of the genus to which it belongs, but a better common name would be BIRCH LEAF SKELETONIZER. The little white objects on the leaves were temporary cocoons built by the caterpillars for protection during moulting, and consequently called moulting cocoons. The insect when full grown makes a regular cocoon in which it changes to a pupa to change later to a tiny moth. Spraying with arsenate of lead when the injury first appears would probably prove an effective remedy in case of a few ornamental trees. The appearance of the injured leaves is shown in Fig. 11.

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[1] *Cacœcia cerasivorana* Fitch.

Among the interesting insects bred during the season was the beautiful HUNTER'S BUTTERFLY,[2] also called the Painted Lady. The caterpillar of this insect may be found on the leaves and among the blossom heads of the common tall Everlasting.[3] They have the peculiar habit of making protective cases by gnawing off the woolly hairs of the food-plant and binding them together with silken threads. The caterpillars remain within or beneath these cases, feeding on the substance of the leaves. As they approach maturity they frequently web together the upper leaves and the flower heads to make a sort of airy cell in the

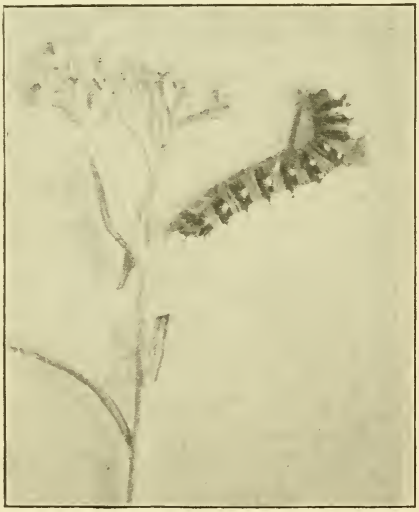

FIG. 8.—Caterpillar of Hunter's Butterfly.

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[1] *Bucculatrix canadensisella* Chambers.

[2] *Pyrameis huntera* Fabricius.

[3] A plant of the genus *Gnaphalium*.

middle of which they remain until full grown. Many of them at this time seem to care less for concealment than they did earlier, as their cottony coverings are more open.

When the caterpillar finally becomes full grown it spins a mass of silk against the upper part of its cell, in which it entangles its hind legs and lets itself hang downward. In a short time it wriggles off its caterpillar skin, changing to the chrysalis which thus hangs in the cell where it remains unchanged for about a fortnight. Then the chrysalis skin splits open and the butterfly drops out and catches hold of the mass of leaves and blossoms with its legs, the body and undeveloped wings hanging downward. In the course of the next half hour the wings expand until they are full size, the front pair being enclosed by the hind pair. Before long the unused muscles acquire more strength, and the newly-fledged butterfly walks up to the top of the flowers where it rests

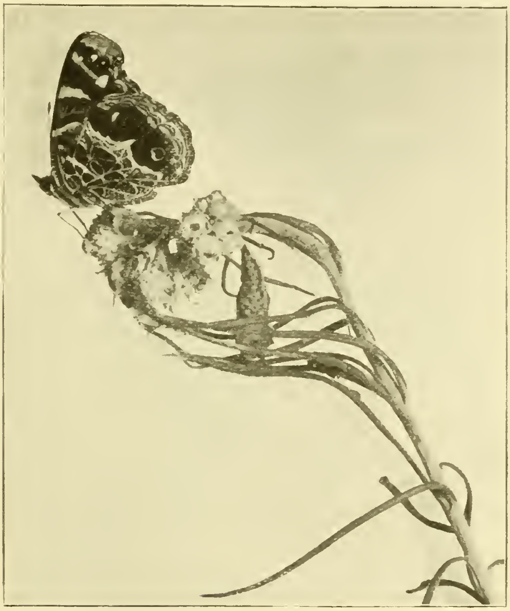

FIG. 9.—Hunter's Butterfly and Empty Chrysalis.

quietly for half an hour or so before taking its first flight. (Fig. 9.)

The Monarch Butterfly[1] was unusually abundant during the season. I mention it here chiefly to record a remarkable display made by this species at Hampton beach early in the autumn. I saw great numbers—hundreds, if not thousands—of these butterflies one morning along the bluff at Little Boar's Head, roosting upon all sorts of shrubbery. Apparently they had been stopped by the ocean on their southward journey, and put up for the night upon the shore of the bluff. Toward noon they flew away and thereafter only a straggler here and there was seen.

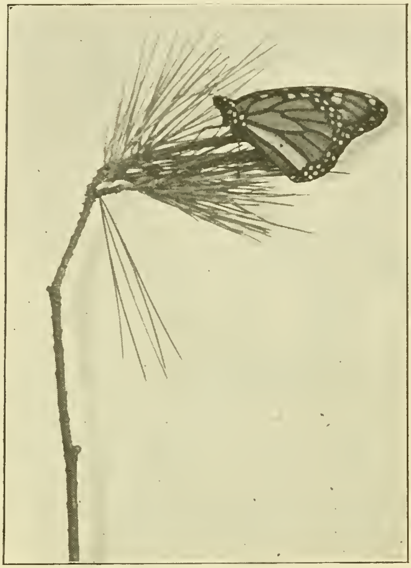

FIG. 10.—The Monarch Butterfly. Reduced.

Early in the season, when the leaves of the apple were first unfolding, great numbers of the APPLE APHIS appeared upon them, and there seemed to be danger that much damage would be done by this insect. Fortunately, however, the threatened attack was averted, and I think the chief agency in reducing the numbers of the plant-lice was that of the warblers and other insectivorous birds which were extraordinarily abundant last May, and stayed with us much longer than is usual on their northward migration. The remarkable number of birds —especially the warblers—was noticed by so many people that it became a common topic of conversation. Everywhere in the apple orchards one could see these tiny friends busily searching the unfolding leaves, for the almost microscopic aphides that swarmed upon them.

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[1] *Danais plexippus* Linné (*archippus* Fabricius).

An insect of comparatively little economic importance, but of much popular interest on account of its extraordinary form is illustrated in Fig 11. This is the WALKING STICK OR STICK INSECT.[1] It was unusually common during the early autumn, occurring upon the leaves and twigs of various trees, especially the oaks and birches. As will be seen from the picture, which illustrates a female specimen, the general re-

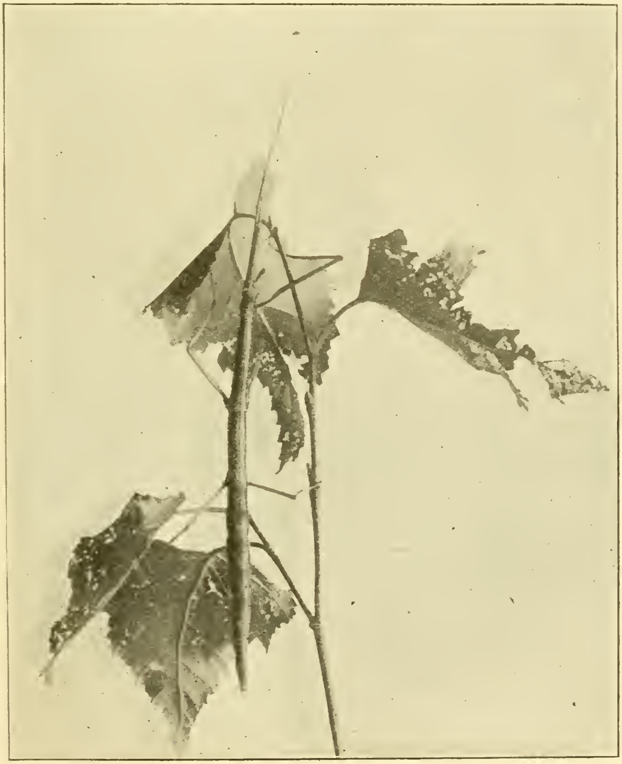

FIG. 11.—The Walking Stick resting on Birch Twig, the Leaves of which were attacked by the Birch Leaf Skeletonizer.

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[1] *Diapheromerae femorata* Say

semblance to a twig is very striking; the body is long and rather slender—much more so in the male—with the legs and antennæ fitting loosely upon it. There are no wings. They feed upon the foliage of various trees. The eggs are dropped to the ground, where they remain throughout the winter. In the spring they hatch into curious little greenish creatures resembling in general form the adult insects. At first they feed near the ground upon the leaves of grasses and bushes, but as they become larger they go higher. They become full grown in about six weeks. Like most insects that mimic their surroundings they remain quiet during the day, and seem to feed chiefly at night.

Bulletin 82 **July, 1901**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

Feeding Farm Horses

BY CHARLES WM. BURKETT

NELL. MAG.

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FEEDING FARM HORSES

I. Introduction.
II. Feeding Experiments with Horses.
III. Water Drank by Horses.
IV. Cost of Feeding Horses.
V. Summary.

Horse raising has become a matter of secondary importance in New Hampshire. This is evident not only from the very small number of colts seen in the state but particularly so from the large purchase of horses for farm purposes outside of our state limits. The farm horse in a way has gone out of date. The writer has been in nearly every section of the state during the past three years and has seen and heard of but few stallions representing the draft and coach breeds. Why should this be so? We are told that horses can be raised more cheaply elsewhere than here. But it does not necessarily follow that the New Hampshire farmer can purchase the horses needed for his work at a less expense than raising them himself.

We export immense quantities of hay of superior quality; we can raise corn for all our purposes, and excepting for freight we can buy concentrated foods as cheaply as the farmer in the West. Why can't we raise our horses, then? The freight charges on a matured work horse are more than the freight on the small quantity of concentrated food necessary for bringing a colt to maturity. We need as many farm horses to-day for our work as the past called for.

The bicycle, the electric car, and the automobile have been with us for some time, and yet they have displaced in no great way the farm labors of the horse. The ox, generally speaking, has gone, while the number of horses has not increased proportionately. Consequently the working units of horse power are down to the minimum. To this reason it seems to me we can attribute the unproductive conditions of our soils. There is too little horse power in the state to properly till and cultivate the soil. We have thousands of acres of tillable land in the state (and what is said here is true of all New England) that have not felt the ploughshare for a long series of years, some for decades, some for a half century. Soil will not remain productive if untilled. We have not enough horses or working units in the state to do the regular farm work and to carry on tillage as it should be done.

Practically the only supply of horses is from other states; yet this state is quite able to supply its full needs and could have to spare for demands elsewhere. The work lies with the farmers themselves, not only to increase the number of working horses but to improve them and make them more serviceable.

By using the better grade of mares for breeding purposes and having the service of some pure-bred sire of some draft or coach breed of good type and conformation, it would be but a short time until the character of the whole horse stock were changed into a better and improved one. Good draft and coach stallions can be secured for about five hundred dollars. Several farmers could purchase a stallion of the type desired, and there could be engaged several mares for the first season at a moderate charge for service which would pay not only a high rate for money invested but would go a long ways for paying the full cost.

PART II

EXPERIMENTS IN FEEDING HORSES

These experiments were conducted through a period of two years, beginning May 1, 1899, and ending May 1, 1901. The five college work horses were used in the experiment during the whole period, their weights taken twice each week, and the number of hours' work recorded. The water drank by each horse during the full time was weighed and recorded.

The first experiment extended through a period of five months, beginning May 1, 1899, and ending Oct. 3, 1899.

COMPARING RATIONS AS TO VALUE AND COST

Ration	*Daily Cost*
Ration No. 1:	19.3
10 pounds hay,	
2 “ bran,	
6 “ corn,	
6 “ gluten feed.	
Ration No. 2:	22.5
10 pounds hay,	
2 “ bran,	
6 “ corn,	
8 “ oats.	
Ration No. 3:	
10 pounds hay,	20.4
8 “ corn,	
7 “ bran.	
Ration No. 4:	
10 pounds hay,	20.0
8 “ corn,	
4 “ linseed oil meal.	
Ration No. 5:	17.4
10 pounds hay,	
1 pound cottonseed meal,	
2 pounds bran,	
8 “ corn.	

The corn was bought at $16 per ton; bran, $17; cotton seed meal, $26; linseed oil meal, $28; gluten feed, $18; oats, 36 cents per bushel; and hay was reckoned at $16 per ton.

Each horse received a different ration, and at the end of a month was fed on another ration, this continuing until each horse had been fed the five different rations; in this way comparing not only the different rations but also comparing their effect on each animal.

TABLE I

EFFECT OF RATION ON WEIGHT. RATION 1.

DAILY RATION No. 1.	ROB. May 1 to June 1.	BESS. June 2 to July 3.	MAUD. July 4 to Aug. 4.	NELL. Aug. 4 to Sept. 4.	MAG. Sept. 4 to Oct. 5.
	Weight.	Weight.	Weight.	Weight.	Weight.
	May	June	July	Aug.	Sept.
10 lbs. hay.	1...1230	1...1240	3...1242	3...1180	4...1250
	4...1240	5...1260	6...1270	7...1177	7 ..1280
2 lbs. bran.	8...1272	8...1270	10...1245	10...1210	11...1250
	11...1225	12...1282	13...1200	14...1175	14...1275
6 lbs. corn.	15...1217	15...1270	17...1240	17...1180	18...1245
	18...1200	19.. 1220	20...1185	21...1217	21...1330
6 lbs. gluten.	22...1215	22...1250	24...1265	24...1295	25...1270
	25...1210	26...1200	27...1265	28...1230	28...1280
Cost of daily ration, 19.3.	28...1205	29...1240	31...1275	31...1185	Oct.
	June	July	Aug.	Sept.	2...1275
	1...1205	3...1240	3...1260	4...1200	5...1247
Work done in hours..	213	153	147	229	222
Water drank........ .	2583	2743	3182	2757	2881

Ration No. 1, which consisted partially of gluten feed, proved quite satisfactory in every sense of the word. The ration is moderate in cost, and all of the horses ate it with a relish. By glancing at the table it will be observed that Rob lost slightly in weight, Bess held her own, Maud gained in weight, Nell also gained in weight, and Mag held her weight throughout the period.

TABLE II

RATION 2. EFFECT ON WEIGHT.

Daily Ration No. 2.	Mag.	Rob.	Bess.	Maud.	Nell.
	May 1 to June 1.	June 2 to July 3.	July 4 to Aug. 4.	Aug. 4 to Sept. 4.	Sept. 4 to Oct. 5.
	Weight.	Weight.	Weight.	Weight.	Weight.
	May	June	July	Aug.	Sept.
10 lbs. hay.	1...1275	1...1205	3...1240	3...1260	4...1200
	4...1277	5...1225	6...1245	7...1270	7...1180
2 lbs. bran.	8...1266	8...1230	10...1242	10...1270	11...1170
	11...1210	12...1225	13...1180	14...1225	14...1180
6 lbs. corn.	15...1270	15...1240	17...1260	17...1240	18...1165
	18...1250	19...1232	20...1270	21...1240	21...1240
8 lbs. oats.	22...1230	22...1250	24...1220	24...1225	25...1180
	25...1200	26...1240	27...1215	28...1225	28...1190
Cost of daily ration, 22.5.	28...1235	29...1235	31...1235	31...1250	Oct.
	June	July	Aug.	Sept.	2...1172
	1...1205	3...1270	3...1220	4...1270	5...1132
Work done in hours..	240	198	178	193	222
Water drank..........	3345	3395	3035	3311	2231

Ration No. 2 was the most expensive fed. This was due because of the oats which formed a part of the ration. The price charged here for oats, while it represents the actual price for the experiment, is rather below the average; the daily charge, therefore, represents the minimum cost of the ration. The table shows that Mag, Bess, and Nell lost in weight, while Rob gained and Maud remained practically the same. The oats in the ration proved no more satisfactory than other feeding stuffs, either in respect to the animal or the efficiency of the work. Had more been fed to keep the weight constant it would have materially affected the price of the ration.

TABLE III

RATION 3. EFFECT ON WEIGHT

DAILY RATION No. 3.	NELL. May 1 to June 1.	MAG. June 1 to July 3.	ROB. July 3 to Aug. 3.	BESS. Aug. 4 to Sept. 4.	MAUD. Sept. 4 to Oct. 5.
	Weight.	Weight.	Weight.	Weight.	Weight.
	May	June	July	Aug.	Sept.
	1...1195	1...1205	3...1270	4 ..1220	4...1270
10 lbs. hay.	4...1195	5...1270	6...1217	7...1200	7...1250
	8...1195	8...1260	10...1240	10...1230	11...1250
8 lbs. corn.	11...1150	12...1300	13...1224	14...1225	14...1290
	15...1170	15...1270	17...1232	17...1225	18...1320
7 lbs. bran.	18...1170	19...1230	20...1220	21...1235	21...1302
	22...1170	22...1260	24...1237	24...1205	25...1312
Cost of daily ration,	25...1130	26...1290	27...1215	28...1235	28...1250
20.4.	28...1160	29...1260	31...1230	31...1210	Oct.
	June	July	Aug.	Sept.	2...1257
	1...1135	3...1260	3...1245	4...1210	5...1257
Work in hours	238	198	176	218	157
Water drank..........	2698	3709	3297	3018	2852

Ration No. 3 is a moderate priced one and like ration No. 1 proved satisfactory. It was the one most liked and relished by all the horses. Feeding too large a quantity of bran, however, seemed to make the animals "soft" and inclined to perspire more freely than the other rations. The table shows that Nell and Bess remained almost constant in weight during the period; Rob's weight fluctuated quite a good deal and gradually dropped; Mag gained during the whole of the period, and Maud reached the highest in weight that she had been during the whole summer. All in all this ration proved healthful, palatable, and moderate in cost.

TABLE IV

RATION NO. 4. EFFECT ON WEIGHT

DAILY RATION No. 4.	MAUD. May 1 to June 1.	NELL. June 2 to July 3.	MAG. July 3 to Aug. 4.	ROB. Aug. 4 to Sept. 4.	BESS. Sept. 4 to Oct. 5.
	Weight.	Weight.	Weight.	Weight.	Weight.
	May	June	July	Aug.	Sept.
	1...1275	1...1135	3...1260	4...1245	4...1210
10 lbs. hay.	4...1270	5...1170	6...1290	7...1220	7...1225
	8...1260	8...1157	10...1240	10...1240	11...1230
8 lbs. corn.	11...1240	12...1172	13...1245	14...1250	14...1240
	16...12 0	15...1177	17...1260	17...1229	18...1215
4 lbs. linseed oil meal.	18...1217	19...1140	20...1260	21...1267	21...1235
	22...1275	22...1177	24...1265	24...1252	25...1200
Cost of daily ration, 20.4.	25...1287	26...1165	27...1250	28...1230	28...1195
	28...1275	29...1175	31...1247	31...1245	Oct.
	June	July	Aug.	Sept.	2...1195
	1...1230	3...1180	3...1260	4...1242	5...1197
Work in hours........	158	200	224	127	187
Water drank..........	2202	3171	3305	2752	2242

Ration No. 4, also a moderate priced one, proved its value throughout the experiment. As much as four pounds of oil meal per day showed no ill effects upon any animal, though it was not eaten with the relish the other rations were. It was soon accepted, however, and the table shows all the horses remained quite constant in weight. Maud and Bess both lost a trifle in weight, while Nell, Mag, and Rob either gained or remained about constant during the periods.

It seems to the writer that two pounds of oil meal and two pounds of bran per day, instead of four pounds of oil meal, would be more satisfactory in the long run.

TABLE V

RATION 5. EFFECT IN WEIGHT

DAILY RATION No. 5.	BESS. May 1 to June 1.	MAUD. June 2 to July 3.	NELL. July 3 to Aug. 4.	MAG. Aug. 4 to Sept. 4.	ROB. Sept. 4 to Oct. 5.
	Weight.	Weight.	Weight.	Weight.	Weight.
	May.	June.	July.	Aug.	Sept.
10 lbs. hay.	1...1237	1...1230	3...1180	4...1260	4...1242
	4...1260	5...1265	6...1190	10...1305	7...1220
1 lb. cotton seed meal.	8...1245	8...1285	10 ..1205	14...1302	11...1235
	11 ..1240	12...1230	13...1180	17...1257	14...1260
2 lbs. bran.	15...1235	15...1355	17...1190	21...1245	18...1280
	18...1237	19...1290	20...1180	24...1300	21...1290
8 lbs. corn.	22...1280	22...1295	24...1190	28. .1277	25...1270
	25...1265	26...1237	27...1150	31...1290	28. .1250
Daily cost of ration, 17.4.	28...1255	29 ..1290	3 ...1180	1260	Oct.
	June.	July.	Aug.	Sept.	2...1245
	1...1240	3...1242	3...1180	4...1250	5...1220
Work in hours........	169	103	208	224	175
Water drank..........	1940	2918	3286	3074	2469

Ration No. 5 was the least satisfactory so far as feeding, for none of the animals relished it, and at first were inclined to avoid the ration because of the cotton seed meal, yet this was the cheapest ration fed. It should be noted that the mixture made the smallest quantity, yet four of the horses either held their own or gained throughout the period, and the fifth at the last weighing lost but a few pounds. So far as effect on weight, this ration proved quite satisfactory, and at the same time very moderate in cost.

From Oct. 3 to Oct. 10 it was thought desirable to compare the five horses, all under same conditions as to hay and work, but each fed a different grain ration. The table following shows the weight of each horse, with 64 hours labor, and rations fed :

TABLE VI

DIFFERENT RATIONS—SAME SEASON OF YEAR; SAME WORK

HORSE.	Date.	Ration No. 1.	Ration No. 2.	Ration No. 3.	Ration No. 4.	Ration No. 5.	Water drank.
Rob	Oct. 5					1220	520
	Oct. 9					1270	
Nell	Oct. 5		1132				580
	Oct. 9		1170				
Mag	Oct. 5	1247					716
	Oct. 9	1310					
Bess	Oct. 5				1197		573
	Oct. 9				1202		
Maud	Oct. 5			1257			703
	Oct. 9			1270			

From a glance at this table we see that all of the horses, when under the same conditions of work, and same season of the year, increased in weight, thus showing that each ration furnished satisfactorily the proper nutrients for the work done. The point of especial interest being the cost of the rations, which varied from 17.4 cents for ration 5 to 22.5 cents for ration 2.

LINSEED OIL MEAL RATIONS

At this point it was thought advisable to further test ration No. 4. There is much said in reference to oil meal as a desirable food stuff, as well as its after effect when another ration is substituted. Accordingly, from Oct. 10 to Nov. 24, all five horses were fed this single ration. Following are the weights :

TABLE VII

RATION NO. 4—OCT. 9 TO NOV. 24

DATE.	ROB.	NELL.	MAG.	BESS.	MAUD.
	Weight.	Weight.	Weight.	Weight.	Weight.
Oct. 9......	1270	1170	1310	1202	1270
“ 12......	1240	1155	1270	1210	1260
“ 16......	1220	1165	1285	1200	1250
“ 19......	1240	1145	1270	1200	1270
“ 23.....	1270	1190	1290	1180	1240
“ 26......	1282	1192	1292	1180	1235
“ 30......	1262	1170	1270	1152	1200
Nov. 2......	1277	1175	1300	1180	1240
“ 6......	1280	1165	1272	1185	1240
“ 9......	1245	1145	1250	1240	1275
“ 13......	1270	1170	1270	1120	1272
“ 16......	1265	1132	1255	1160	1220
“ 20......	1251	1145	1270	1190	1242
“ 23......	1280	1125	1272	1195	1260
Work done in hours...	209	314	314	302	291
Water drank	3625	3355	4856	3897	4600

On Nov. 24 the rations were again changed. Rob was fed the corn-bran-cotton seed meal ration; Nell, corn, bran, and oats; and Mag, corn and bran. This extended until January 26, and the table following shows the weights:

TABLE VIII

RATIONS FOLLOWING LINSEED MEAL RATION

Date.	Rob.	Nell.	Mag.
	1 lb. cotton seed meal. 2 lbs. bran. 8 lbs. corn. 10 lbs. hay.	2 lbs. bran. 6 lbs. corn. 8 lbs. oats. 10 lbs. hay.	8 lbs. corn. 7 lbs. bran. 10 lbs. hay.
Nov. 26	1280	1125	1272
" 27	1251	1155	1250
" 30	1255	1175	1290
Dec. 4	1225	1172	1287
" 7	1245	1145	1270
" 11	1255	1180	1305
" 14	1252	1160	1220
" 18	1260	1157	1285
" 21	1270	1150	1270
" 25	1260	1185	1292
" 28	1250	1180	1297
Jan. 1	1265	1180	1292
" 4	1275	1185	1295
" 8	1260	1185	1292
" 11	1282	1182	1307
" 15	1250	1180	1260
" 18	1275	1185	1275
" 22	1258	1190	1280
" 25	1265	1190	1290
Work done in hours	302	439	439
Water drank	3644	3626	5500

From this table we see three horses changed from a linseed oil meal ration to three entirely different ones did not lose in weight. Rob dropped in weight after the first weighing, and after that during the period either held his own or gained. Mag and Nell both increased in weight, doing the same kind of work and same number of hours' work, though on different rations. There is nothing to show in this experiment that "once begin the use of linseed oil meal it is necessary to continue its use to keep up the general weight." Even when changed abruptly there is no decided effect seen.

Going back now to Nov. 24, we left Bess and Maud on the linseed oil meal ration. This ration was continued until Dec. 9 with Bess, but Maud was fed ration No. 1 until the same date. The following table shows the weights:

TABLE IX

HORSE AND RATION

Date.	Bess.	Maud.
	10 lbs. hay. 4 lbs. linseed oil meal. 8 lbs. corn.	10 lbs. hay. 2 lbs. bran. 6 lbs. gluten feed. 6 lbs. corn.
Nov. 23	1195	1260
“ 27	1185	1235
“ 30	1190	1260
Dec. 4	1170	1245
“ 7	1180	1220
“ 10	1155	1225
Work done in hours	105	101
Water drank	1217	1341

On Dec. 10 the rations were reversed and then continued until Jan. 26. The weights are given in

TABLE X

HORSE AND RATION

Date.	Bess.	Maud.
	10 lbs. hay. 2 lbs. bran. 6 lbs. gluten feed. 6 lbs. corn.	10 lbs. hay. 4 lbs. linseed oil meal. 8 lbs. corn.
Dec. 10	1155	1225
" 14	1165	1222
" 18	1177	1227
" 21	1165	1222
" 25	1165	1220
" 28	1170	1210
Jan. 1	1172	1220
" 4	1165	1190
" 8	1185	1212
" 11	1185	1220
" 15	1157	1182
" 18	1170	1190
" 22	1172	1205
" 25	1180	1240
Work done in hours	302	302
Water drank	3619	3997

These two tables show us that an abrupt change makes no material difference in the weight; neither did a change from a linseed oil meal ration to a gluten feed ration, as seen in Table X, or from a linseed oil meal ration to cotton seed meal-corn-bran, corn-bran-oats, or corn-bran, as seen in Table VIII, cause a falling off in weight.

It seems clear to us that there is no so-called single ration for horses. Any food stuff or combination of food stuffs that furnishes desirable nutrients at least cost should be considered in the preparation of rations.

COMPARING CORN STOVER AND TIMOTHY HAY IN HORSE FEEDING

Corn stover, while long recognized as a valuable food for all kinds of cattle, has not received the attention it should as a food for the farm horses. To compare its value with high quality timothy hay, a part of the 1899 corn crop was cut and dried in the field, and after being husked the stover was taken to the barn and stored. The stover was then run through the ensilage cutter and taken to the horse barn where it was fed to form a part or all of the roughage in the horse rations. Five rations were made as follows:

Ration A	6 lbs. corn stover,
	6 lbs. hay,
	7 lbs. corn,
	4 lbs. oats,
	3 lbs. bran.
Ration B	12 lbs. hay,
	7 lbs. oats,
	7 lbs. corn.
Ration C	12 lbs. corn stover,
	7 lbs. oats,
	7 lbs. corn.
Ration D	12 lbs. corn stover,
	7 lbs. bran,
	7 lbs. corn.
Ration E	12 lbs. hay,
	7 lbs. bran,
	7 lbs. corn.

This plan gave us a double comparison; that of hay and stover and oats and bran. It was begun January 26 and continued until April 9.

TABLE XI

COMPARING CORN STOVER AND TIMOTHY HAY

Date.	Horse and Ration.				
	Rob.	Nell.	Mag.	Bess.	Maud.
	6 lbs. corn stover. 6 lbs. timothy hay. 7 lbs. corn. 4 lbs. oats. 3 lbs. bran.	12 lbs. hay. 7 lbs. oats. 7 lbs. corn.	12 lbs. corn stover. 7 lbs. oats. 7 lbs. corn.	12 lbs. corn stover. 7 lbs. bran. 7 lbs. corn.	12 lbs. hay. 7 lbs. bran. 7 lbs. corn.
Jan. 26	1265	1190	1290	1180	1240
29	1282	1212	1280	1200	1270
Feb. 1	1260	1200	1290	1180	1275
5	1300	1230	1287	1190	1270
8	1272	1210	1272	1175	1270
12	1265	1225	1290	1180	1305
15	1285	1230	1310	1200	1315
19	1275	1210	1295	1200	1310
22	1267	1222	1295	1195	1312
26	1280	1242	1300	1220	1350
Mar. 1	1310	1245	1310	1180	1320
5	1275	1240	1290	1165	1280
8	1285	1225	1287	1147	1230
12	1300	1245	1300	1140	1240
15	1307	1220	1307	1165	1290
19	1320	1245	1305	1170	1320
26	1305	1247	1320	1190	1290
29	1300	1247	1290	1145	1280
Apr. 2	1312	1227	1282	1185	1305
5	1285	1245	1307	1160	1295
9	1285	1250	1290	1185	1255
Work done in hours	306	360	364	129	121
Water drank	3115	2986	3072	2726	4300

From this table we see that Rob, on his ration, gained a trifle, Mag remained practically the same in weight, while Nell, Bess, and Maud all gained in weight. Mag and Nell did the same kind of work and the same number hours' work, and were fed the same grain ration. Nell gained in weight, and Mag remained the same almost constantly during the seventy-three days. Where corn and oats were fed to furnish the grain part of the ration the advantage was slightly in favor of the hay. In this respect then corn stover proved of practically equal value to timothy hay, and was furnished at but one third the cost. Taking up Bess and Maud we find equally interesting facts. Both were fed equal quantities of grain, both did the same kind of work and nearly equal in amount. Both increased in weight during the run of the experiment, the advantage being in favor of Maud.

With these two animals it was likewise a comparison of corn stover and timothy hay. The grain, however, was different, corn and bran having been fed them instead of corn and oats which had been given Mag and Nell.

Not once during the seventy-three days did either weigh less than at the beginning. So comparing these two roughage foods, where corn and bran were fed as the grain part of the ration, one seems to be quite the equal of the other.

Hay and corn stover have thus been compared on two common kinds of grain mixture, with results almost equal, the advantage being a trifle in favor of corn stover. When we consider the relative values of timothy hay and corn stover, commercially, we will realize then how important that the latter be utilized whenever it is available. We can grow from three to five tons of dry matter per acre in form of the corn plant, but scarcely a couple tons per acre in form of timothy hay. This gives a double reason for a more extended use of corn in all its forms.

From the above experiment we can see that where the farm horse during the winter season is not put to very strenuous work corn stover can be utilized as the whole of the roughage, thereby materially decreasing the cost of keeping the farm work during that time.

Going back to the table again let us see in reference to the grain part of these rations. Take Nell and Maud, where hay was the constant factor. Nell, fed on oats and corn, slightly gained in weight; but Maud, fed on bran and corn, gained as much. Taking corn stover now as the constant factor, Mag on corn and oats remained constant in weight during the period, while Bess made a slight gain.

The conclusion may be drawn from this experiment that corn stover has a feeding value, when fed either with corn and oats or corn and bran in the proportions it has been here, equal to timothy hay, and also when corn stover or timothy hay furnish the roughage of a ration, oats and corn half and half, and bran and corn half and half, have, generally speaking, equivalent feeding values.

This experiment so far as it touches on grain constituents of a ration is quite consistent with the conclusions evident from the facts of Ration 2 as previously discussed.

FURTHER COMPARISON OF FOOD STUFFS

It was thought advisable to continue this same comparison to determine if during a long period and a summer period there were a substitute for oats for feeding horses. Consequently, beginning April 10 the five college work horses were continued with the grain mixtures fed during the winter period. This was extended until October 9. Corn stover was dropped from the rations and twelve pounds of timothy hay were fed daily to each horse. Each animal was weighed twice each week, but instead of giving the weighing for the whole period the average for the first half and last half of each month during the period is given.

TABLE XII

COMPARING CORN AND OATS WITH CORN AND BRAN

	Horse and Ration.				
	Rob.	Nell.	Mag.	Bess.	Maud.
Date.	12 lbs. hay. 7 lbs. corn. 4 lbs. oats. 3 lbs. bran.	12 lbs. hay. 7 lbs. corn. 7 lbs. oats.	12 lbs. hay. 7 lbs. corn. 7 lbs. oats.	12 lbs. hay. 7 lbs. corn. 7 lbs. bran.	12 lbs. hay. 7 lbs. corn. 7 lbs. bran.
Beginning April 9....	1285	1250	1290	1185	1255
Average.					
Last half April........	1264	1247	1322	1197	1308
First half May........	1266	1249	1309	1195	1306
Last half May........	1260	1224	1294	1206	1300
First half June........	1265	1218	1293	1206	1293
Last half June........	1255	1209	1297	1218	1313
First half July........	1275	1244	1325	1240	1314
Last half July........	1250	1222	1337	1228	1300
First half August.....	1247	1232	1324	1250	1314
Last half August.....	1285	1231	1313	1240	1316
First half September	1285	1235	1356	1232	1321
Last half September	1257	1236	1344	1247	1331
October 1	1300	1245	1380	1280	1370
4	1280	1225	1365	1280	1365
8	1295	1230	1365	1275	1390
Work done in hours..	1148	1417	1391	1252	1279
Water drank..........	15785	15639	20711	17744	18913

This table shows some variation in weights where hay and corn were the constant factors, but the remaining grain different. Rob practically remained even in weight, Nell and Bess each lost a trifle, while Mag and Maud both gained considerably, the latter weighing even more than she had any time during the past year and a half.

The results show conclusively that bran can be substituted for oats which is a more expensive food. A ton of oats contains 1,014 pounds of digestible nutrients which cost $22.32. A ton of bran contains 1,082 pounds of digestible nutrients which cost but $17 per ton, a saving difference of $5.32 on each ton used.

COMPARISON OF BRAN AND OATS FOR WINTER FEEDING

At the close of the period just discussed, we thought it advisable to continue the same rations during the winter period. Rob was continued on his same ration, while the other horses were changed each to another ration. While each animal was weighed twice each week, the averages for the first half and the last half of each week are given instead of the actual weighings. The whole data are shown in the following table as follows :

TABLE XIII

WINTER COMPARISON OF CORN AND OATS WITH CORN AND BRAN

DATE.	ROB.	NELL.	MAG.	BESS.	MAUD.
	12 lbs. hay. 7 lbs. corn. 4 lbs. oats. 3 lbs. bran.	12 lbs. hay. 7 lbs. corn. 7 lbs. bran.	12 lbs. hay. 7 lbs. corn. 7 lbs. bran.	12 lbs. hay. 7 lbs. corn. 7 lbs. oats.	12 lbs. hay. 7 lbs. corn. 7 lbs. oats.
Oct. 11, average	1315	1220	1320	1250	1345
Last half Oct..........	1281	1217	1337	1282	1347
First half Nov.	1256	1212	1347	1274	1347
Last half Nov.........	1295	1245	1391	1288	1365
First half Dec.........	1256	1212	1347	1274	1374
Last half Dec...	1295	1246	1391	1290	1360
First half Jan.........	1281	1226	1352	1275	1341
Last half Jan..........	1286	1219	1363	1255	1351
First half Feb	1281	1244	1349	1275	1378
Last half Feb..........	1276	1230	1340	1297	1396
First half March......	1245	1260	1350	1305	1360
Last half March	1295	1257	1350	13[illegible]5	1390
First half April.......	1265	1257	1366	1312	1420
April 29................	1235	1245	1300	1315	1370
Work done in hours..	805	1257	1259	954	914
Water drank..........	10,783	10,585	14,369	11,425	12,026

Here again we see both rations as given caused all the horses excepting Rob to increase in weight during the winter period. Nell and Mag each did practically twenty-five per cent. more work during the period than either of the others and yet held their weight. These long periods of both summer and winter feeding show the value of the corn-bran ration for horses. These results evident from these experiments are fully consistent with all that has preceded.

PART III

WATER CONSUMED BY HORSES

At the beginning of the two years' experiments in horse feeding, the writer deemed it advisable to keep a record of the full amount of the water drank by each of the five horses during the time they were being used for experimentation. Each horse was watered three times each day and the water drank recorded.

The following table shows the amount of water drank by each and covering the periods of the special rations:

TABLE XIV

TOTAL WATER CONSUMED IN TWO YEARS, BY PERIODS

Period.	Water consumed in pounds.				
	Rob.	Nell.	Mag.	Bess.	Maud.
May 1 to June 1	2583	2698	3345	1940	2202
June 1 to July 2	3395	3171	3709	2743	2918
July 2 to Aug. 2	3297	3286	3305	3035	3182
Aug 2 to Sept. 2	2752	2757	3074	3018	3311
Sept. 2 to Oct. 3	2469	2231	2881	2242	2852
Oct. 3 to Oct. 10	520	580	716	573	703
Oct. 10 to Nov. 24	3625	3355	4856	3897	4600
Nov. 24 to Dec. 10	....	....	....	1217	1341
Dec. 10 to Jan. 26	....	....	....	3619	3997
Nov. 24 to Jan. 26	3644	3626	5500	....	....
Jan. 26 to April 9	3115	2986	3072	2726	4300
April 9 to Oct. 9	15,785	15,639	20,711	17,744	18,913
Oct. 9 to May 1	10,783	10,585	14,369	11,425	12,026
May 1, 1899, to May 1, 1900	26,770	25,895	31,458	26,660	30,546
May 1, 1900, to May 1, 1901	24,745	24,675	32,997	27,262	28,910
Total for two years	51,515	50,570	64,455	53,922	59,456

WATER IN REFERENCE TO FEEDING RATIONS

The influence of feed on water drank is shown in the following tables:

TABLE XV

WATER DRANK AS INFLUENCED BY FEED

HORSE.	RATION 1.	RATION 2.	RATION 3.	RATION 4.	RATION 5.
	2 lbs. bran. 6 lbs. corn. 6 lbs. gluten feed. 10 lbs. hay.	2 lbs. bran. 6 lbs. corn. 8 lbs. oats. 10 lbs. hay.	8 lbs. corn. 7 lbs. bran. 10 lbs. hay.	8 lbs. corn. 4 lbs. linseed oil meal. 10 lbs. hay.	8 lbs. corn. 1 lb. cotton seed meal. 2 lbs. bran. 10 lbs. hay.
	Water drank.	Water drank.	Water drank.	Water drank.	Water drank.
Rob	2583	3395	3297	2752	2469
Nell	2757	2231	2698	3171	3286
Mag	2881	3345	3709	3305	3074
Bess	2743	3035	3018	2242	1941
Maud	3182	3311	2852	2202	2918
Average	2829.2	3063.4	3114.8	2734.4	2737.6
Total work performed	964	1031	987	894	879

It will be seen by this table that feed does exert an influence on the amount of water consumed. All five rations were fed from May 1 to Oct. 3; each was affected equally, doubtless by the individuality of the horses and the periods, but all were under precisely uniform conditions in respect to animals, periods of feeding, etc.

The corn-bran ration consumed the largest quantity of water, followed in this respect by Ration 2, 1, 5, and 4 respectively.

Even making adjustments as to total work done, practically the same comparisons hold.

WATER IN REFERENCE TO INDIVIDUALITY OF THE HORSE

A study of water consumed by each horse offers an interesting comparison. Taking these five periods extending from May 1 to Oct. 3, during which time each horse was fed the five rations, we find the following:

TABLE XVI

WATER AND INDIVIDUALITY OF HORSES

RATION.	ROB.	NELL.	MAG.	BESS.	MAUD.
No. 1....................	2583	2757	2881	2743	3182
No. 2....................	3395	2231	3345	3035	3311
No. 3....................	3297	2698	3709	3018	2852
No. 4....................	2752	3171	3305	2242	2202
No. 5.............	2469	3286	3074	1941	2918
Total water drank....	14,496	14,143	16,314	12,979	14,465
Total hours' work during periods......	889	1097	1118	904	758

We see by this table that Nell and Mag did practically the same number of hours' work and they also did exactly the same kind yet there is a difference of over 2,000 pounds of water drank. Bess and Maud were used together most of the time, and when so used did the same kind of work, yet Maud, doing less work than Bess, drank about 1,500 pounds more water than Bess. Rob did less work than either Nell or Bess, and he consumed more water than either.

This table shows convincingly that the amount of water consumed is dependent to a greater or less extent upon the individuality of the animal. The amount of work which the animal does seems to be a less important factor.

Taking the period from Nov. 24 to Dec. 9, when all five horses were on precisely the same ration, and did nearly equal hours of work, we find that Rob drank 3,625 pounds of water; Nell, 3,355; Mag, 4,856; Bess, 3,897, and Maud, 4,600. Here are nearly the same variations of water drank as seen in the preceding table, showing that the amount of water consumed depends, more or less, on the individuality of the horse.

By glancing back over the earlier pages of this bulletin, where feeding stuffs are considered in reference to the weights of the animal, the reader will observe the same variations in reference to water consumed, Mag practically all the time drinking the most, followed in order by Maud, Bess, Rob and Nell.

WATER AND WORK

The following table shows the total number of hours' work done by each horse during the whole of the two periods, and the total water consumed for the same time:

TABLE XVII

SHOWING WATER DRANK AND WORK DONE

	Hours' Work Done.				
Period.	Rob.	Nell.	Mag.	Bess.	Maud.
May 1 to June 1	213	238	240	169	158
June 1 to July 2	229	200	198	153	103
July 2 to Aug. 2	176	208	224	178	147
Aug. 3 to Sept. 3	127	229	224	218	193
Sept. 3 to Oct. 3	175	222	222	187	157
Oct. 3 to Oct. 10	57	66	63	62	62
Oct. 10 to Nov. 24	209	314	314	....	291
Oct. 10 to Dec. 9	....	....	....	393	
Nov. 24 to Dec. 9	....	....	....	....	101
Nov. 24 to Jan. 26	302	439	439	....	
Dec. 9 to Jan. 26	....	....	....	302	302
Jan. 26 to April 9	306	360	364	129	121
April 9 to Oct. 9	1148	1417	1391	1252	1279
Oct. 9 to May 1, 1901	805	1257	1259	954	914
Total, May 1, 1899 to May 1, 1901	3747	4950	4938	3997	3828
Water consumed during the two years.	51,515	50,570	64,455	53,922	59,456

From this table we see that the horse having done the greatest amount of work drank the smallest quantity of water, while the horse doing the least work during the two years drank next to the largest quantity of water.

It is reasonable to conclude, however, that work does to a certain extent influence the water consumption; and it is equally true that different food rations likewise affect the water consumption. The ruling factor, nevertheless, is the individuality of the animal.

PART IV

COST OF FEEDING HORSES

The total cost of feeding the five horses is readily obtained by determining the total quantities of food stuffs used during the two years of experimentation. The following table gives the quantities of each food stuff consumed during that time:

TABLE XVIII

TOTAL FOOD STUFFS USED

Horse.	Food Stuffs, Quantity in Pounds.							
	Oats.	Corn.	Gluten feed.	Linseed oil meal.	Cotton seed meal.	Bran.	Hay.	Corn stover.
Rob............	2080	5242	186	304	101	1917	7308	438
Nell............	2600	5102	186	304	31	1957	7746	
Mag...........	2040	5228	408	124	31	2272	6870	876
Bess.	1662	5146	474	392	31	2291	6870	876
Maud...	1662	4852	276	316	31	2274	7746	
Total......	10,044	25,570	1530	1440	225	10,711	36,540	2190

The total cost of feed for the five horses for the whole period is shown in the following summary:

10,044 pounds oats at 36 cts. per bushel..................	= $113.00
25,570 pounds corn at $16 per ton........	= 204.56
1530 pounds gluten at $18 per ton...................... ..	= 13.77
1440 pounds linseed oil meal at $28 per ton.............	= 20.16
225 pounds cotton seed meal at $26 per ton..............	= 2.93
10,711 pounds bran at $17 per ton.........................	= 91.04
36,540 pounds timothy hay at $16 per ton.................	= 292.32
2190 pounds corn stover at $5.00 per ton.................	= 5.48
Total for two years..................................	$743.26
Average cost for each horse per year...........	74.32

The cost of keeping a horse is easily determined when the ration is fixed. The kind of roughage to be fed ordinarily depends upon circumstances; and this is equally true of the grain. Perhaps in feeding horses it is best not to rely upon a single ration; a change is as desirable to them as ourselves.

The preceding experiments show that the feeding of oats is not necessary to maintain the desired weight of the work horse, nor necessary for efficient labor. Their use also renders the ration more costly than any other fed.

For winter feeding when horses are on light work a ration consisting of corn stover, bran, and corn is fully as desirable as timothy hay, corn, and oats, and is furnished at less than two thirds the cost.

COST OF FEED AND WORK

Throughout the two years the five horses were under the same conditions of shelter, water, grooming, etc. The table below gives the weights of each horse at the beginning and ending of two years' experiment:

TABLE XIX

WEIGHTS AT BEGINNING AND ENDING OF EXPERIMENTS

DATE.	ROB.	NELL.	MAG.	BESS.	MAUD.
Beginning May 1, 1899....................	1230	1195	1275	1237	1275
Ending May 1, 1901......................	1235	1245	1300	1315	1370

It will be seen by this that all horses gained during the time which would indicate that none of them was overworked or underfed. A study of the relation between cost of food and work done would not mean therefore a comparison of maximum conditions, but rather the average and ordinary.

Glancing back at table XVII it will be noted that during the two years Rob did 3,747 hours' work; Nell, 4,950; Mag, 4,938; Bess, 3,997; and Maud, 3,828; a grand total of 21,460 hours.

To feed the five horses to do this amount of work required during the two years $743.26, or for every hour's work done 3.4 cents.

The writer desires to acknowledge the patient help and careful assistance given him by Mr. H. P. Richardson, assistant in this department, and Mr. James Dickson, also in this department, during the two years covering the experiments.

PART V

SUMMARY

1. More working units of horse power are needed for the improvement of our soil.
2. Pure-bred sires of coach and draft breeds are necessary for the improvement of the farm horse stock of the state.
3. Various kinds of food stuffs can be used to advantage and with economy in feeding horses.
4. There is no so-called "one ration for horses."
5. Any food stuff or combination of food stuffs, furnishing the desirable nutriment at least cost, should be considered in preparing rations for horses.
6. A mixture of bran and corn, half and half, is a good substitute for corn and oats for feeding work horses.
7. Corn stover is a good substitute for timothy hay for winter feeding of horses because of its feeding value, the yield per acre and commercial value.
8. A change from a grain mixture, consisting partially of linseed oil meal, slowly or abruptly, does not cause a decrease in weight in horses, if a proper substitute ration is fed.
9. Feed influences the quantity of water drank by work horses.
10. Labor influences also the quantity of water drank by work horses.
11. The individuality of the horse has greatest effect on quantity of water drank.
12. The quantity of water drank by the five college farm horses varied from 25,895 pounds per year to 32,997 pounds.
13. The average total cost per year for actual food supply per horse was $74.32.
14. The average cost for feed per hour's work done during two years was 3.4 cents.

Bulletin 83 **August, 1901**

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THE VALUE OF MEADOW MUCK

BY FRED W. MORSE

In order to use meadow muck with economy it is necessary to know something about its value in comparison with barnyard manure. This bulletin is intended to show the comparative values per cord of the two materials, based on data taken from the work of our agricultural experiment stations.

The amount of fertility in barnyard manure was reckoned from analyses of nineteen different lots used by the Massachusetts Experiment Station[1] in a series of coöperative field experiments. These lots of manure were from different farms and represented actual farm-practice, which makes them more suitable for this bulletin than the average of all analyses published in experiment station literature.

The average percentage composition of these manures was

Water.	Nitrogen.	Phosphoric acid.	Potash.
70.27	.387	.249	.388

Six of the lots had the organic matter in them determined with an average result of 26.74 per cent.

In a part of the experiments the manure was both weighed and measured with the result that eleven lots ranged between

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[1] Mass. Hatch Exp. Sta. Bulletins 9 and 14.

5,120 pounds and 7,400 pounds per cord, and gave an average for all of 6.060 pounds per cord, or approximately three tons.

On a basis of three tons, one cord of the average barnyard manure would contain

Nitrogen.	Phosphoric acid.	Potash.	Organic matter.
23 1-4 lbs.	15 lbs.	23 1-4 lbs.	1,600 lbs.

The average composition of wet meadow muck was calculated from the results of ten analyses made at this station together with twenty eight reported from the Vermont and ten from the Maine Experiment Stations.[1]

Water, nitrogen, and organic matter are the only constituents considered in the mucks because potash and phosphoric acid are not present in quantity and of availability sufficient to warrant analysis.

The average percentages of water and nitrogen in 48 samples and of organic matter in 29 samples were as follows:

Water.	Nitrogen.	Organic matter.
77.36	.452	17.04

The mucks were somewhat wetter than the manures, the former having from 55 to 89 per cent. of water and the latter from 53 to 79 per cent.

No weights of a cord of wet muck have been found, therefore it has been necessary to assume that a cord of it is as heavy as a cord of manure, which is probably an underestimate.

On the basis of three tons, a cord of the average muck would contain

Nitrogen.	Organic matter.
27 lbs.	1,022 lbs.

To put the muck on a basis comparable with the manures, the following facts have been considered.

In fertilizers, nitrogen costs about three times as much as available phosphoric acid and potash.

Therefore the 38 1-4 pounds of phosphoric acid and potash in the cord of manure would be equivalent to 12 3-4 pounds of nitrogen, and its total fertilizing constituents would be equivalent to 36 pounds of nitrogen.

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[1] Vermont Exp. Sta. Repts. 1890 to 1899. Maine Exp. Sta. Bull. 74.

Experiments at the New Jersey Experiment Station[1] have shown that the nitrogen in fresh solid and liquid manure is as available as the nitrogen in ammonia salts and dried blood, but the nitrogen left in such manure after prolonged leaching is but three eighths as available. It is not known whether the nitrogen of muck is as available as that in leached manure ; but for convenience it is assumed to be equally so. On this basis 27 pounds of nitrogen in a cord of muck would be equivalent to about 10 pounds of nitrogen in barnyard manure. The organic matter in muck may be considered worth as much as that in manure.

Therefore on the basis of fertilizing constituents as calculated, *one cord of manure is worth three and one half cords of muck, while on the basis of organic matter, a cord of manure is equivalent to one and one half cords of muck.*

In connection with the amount of organic matter in muck, it is of interest to consider the amount of organic matter turned under in a crop of rye. Experiments at the Pennsylvania Experiment Station[2] show an average yield of 1.800 pounds of organic matter per acre in a crop of green rye at the stage of growth when it could be plowed under, or about 18 inches in height. *Two cords of average muck would be fully equivalent to this amount of organic matter.*

It is often the case that muck is exposed to the weather for several months, in order to dry it. One experiment is reported by the New York Experiment Station[3] in which the changes undergone in such weathering are shown. In a year of exposure, a compost consisting largely of muck lost over one fifth of its nitrogen. In compiling the muck analyses used in this bulletin, it was noticed that the dry mucks contained less nitrogen in dry matter than the wet mucks, and upon comparing averages it was found that 20 mucks with low percentages of water contained only 1.55 per cent. of nitrogen in the dry matter,

[1] New Jersey Exp. Sta. Rept. 1900.

[2] Pennsylvania Exp. Sta. Repts. 1886 and 1893.

[3] New York State Exp. Sta. Bull. 23, new series.

while the 48 wet mucks had 2.00 per cent. The experimental and the analytical results both show that muck should be dried under cover, when it is being prepared as an absorbent.

Since mucks vary widely in their nature, ranging as they do from a nearly true peat to a soil that is practically a clay loam, excepting its black color, the experiment station urges the farmers of New Hampshire to send it samples of muck for analysis.

The muck should be sent in a fresh, wet condition, packed in a tight wooden box holding about one half cubic foot, and with express charges prepaid.

Bulletin 84 **September, 1901**

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

FORCING
DWARF TOMATOES
UNDER GLASS

Second Picking.

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

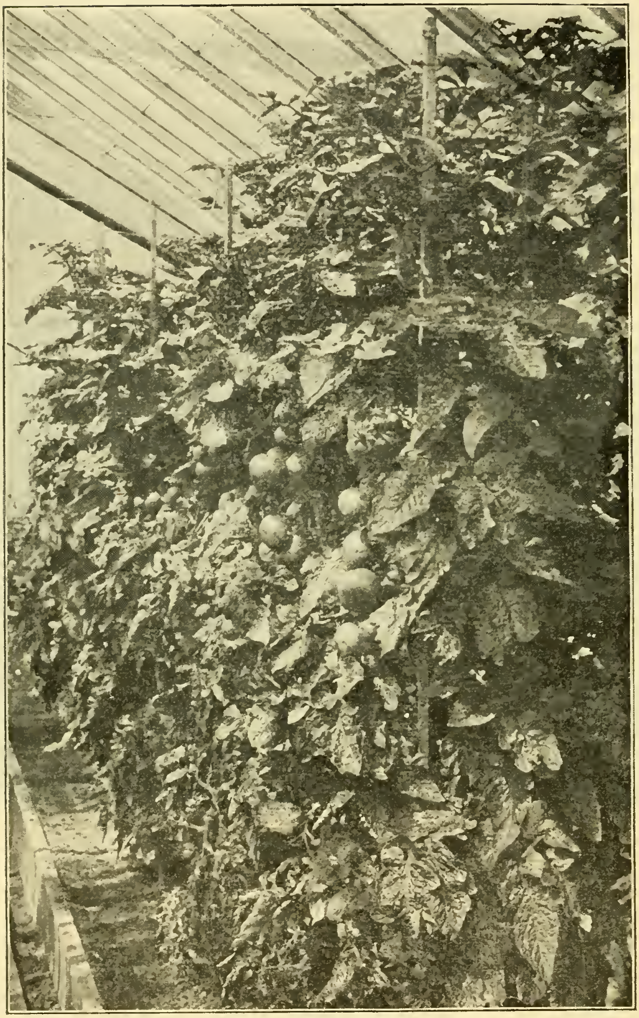


FIG. 2. Dwarf Tomatoes trained to one stem at average height of 7½ ft. Lower clusters all picked.

FORCING DWARF TOMATOES UNDER GLASS

BY F. WM. RANE

The varieties of tomatoes commonly used for forcing purposes are the tall or standard sorts. The Lorillard is generally considered the best standard variety although various other varieties are grown. Experience has proven that under ordinary conditions best results are obtained by training these varieties to one stem.

The Dwarf Champion and other dwarf varieties have been thought of little value for forcing under glass other than to utilize them to some extent on side benches, or in places where overhead space was not sufficient for training up the others.

The purpose of this bulletin is to emphasize the value of the dwarf varieties. It is believed that the value of the dwarfs when trained to one stem has never heretofore received sufficient attention.

A few years ago when carrying on some soil exhaustion experiments under glass one of the dwarf varieties of tomatoes was used in the test. In order to make the conditions uniform each plant was trained to a single stem. The behavior of these plants indicated certain advantages over the taller growing varieties. They ripened fruit early, the plants were more stalky, the fruit clusters were much nearer together and the plants did not reach the glass nearly so quickly as the tall-growing sorts.

In discussing varieties for forcing in Bulletin No. 28, "Experiments in the Forcing of Tomatoes," the Cornell Experiment Station, after naming a list of varieties used in the test, says: "Of these the Dwarf Champion (the only dwarf) is least satisfactory. It does not grow high or free enough to allow of convenient training, and the fruit is small and ripens slowly." It is understood that in this test an attempt was made to train all the varieties to a single stem. This is the only instance the writer is aware of in which a dwarf variety of tomatoes has been trained to a single stem for the purposes named. The fact that they were trained to strings as supports and were probably shaded by the other varieties would account for the unfavorable results.

At the New Hampshire station dwarf varieties have been grown for the past three years, and have been trained to a single stem, but not on any large scale until the season of 1900–1901. At this time a greenhouse suitably adapted for the purpose was set aside for the experiment.

The house used is 32 by 25 feet in dimensions. The beds, with the exception of one side bench which was not used in the experiment and is four feet wide running the length of the house, are directly on the ground. This gives plenty of overhead space and is well adapted for growing tall-growing crops. The heat is supplied by steam from two coils of pipes on each side of the house. One coil is directly under the side bench, which is raised, while the other hangs on the opposite side, both running lengthwise of the house. Each coil is so arranged that either one half or the whole radiating surface can be used, thus giving an opportunity to regulate the temperature very easily. The house is also equipped with a Johnston thermostat. By this an even temperature is readily maintained. The proper temperature for tomatoes is between 60° and 70° at night, and between 70° and 80° or more during the day. The tomato needs plenty of moisture. The only time when a humid atmosphere may be objectionable is when the fruit is setting.

Soil and Fertilizers.—We have been successful by using a well enriched soil, containing an abundance of available plant food. That used by us was a sandy loam composted by mixing equal parts of rich dark loam, sand, and manure. The beds were ground beds and the prepared soil averged about six inches in depth. The subsoil was loosened up to about the same depth before the other was put in. After the plants had been bearing for a short time and in order to provide enough plant food, they were watered once or twice a week with liquid manure. As the plants grew older a larger quantity of liquid manure was used than at first.

Sowing the Seed and Transplanting.—On September 27 seeds were sown in trays in the greenhouse, of the following varieties of dwarf tomatoes: Dwarf Champion, Dwarf Golden Champion, and La Cross Seedling. When large enough to handle they were transplanted and kept in pots until the 27th of December when other crops had made way and a house adapted for their forcing was ready. At this time the plants were three months from seed, about eight to ten inches in height, stalky, and in fine shape. The first fruits from this transplanting were picked from the Golden Dwarf Champion on March 23, and from the other two varieties on March 29. It should be said here, however, that this date would have been much earlier but for a mistaken idea of the attendant in picking off all of the first clusters of blossoms. He reasoned that the plants needed the strength and should not set fruit too soon after being transplanted. This unfortunate occurrence may also have lessened our maximum yield.

In "The Forcing Book," Bailey, it is indicated that the time required from seed to fruit for the tall-growing sorts is from four to five months, when the seed is sown in August. When the seed is sown in November, on account of the dark weather and shorter days, it requires a much longer time, six months at least.

It is evident that under similar conditions the time from seed to maturity is practically the same for both dwarfs and standard varieties.

Training.—Tomatoes trained to one stem must have some kind of a support and this once arranged they are tied up as occasion requires thus keeping each plant in place. We have tried both heavy cord and wooden strips as supports and prefer the latter. The method of training on a cord is not satisfactory as the string does not stand stalwart enough; as the plants grow and increase in weight the cord has a tendency to give. The dwarfs are perhaps worse in this respect than the tall-growing varieties until they are well established.

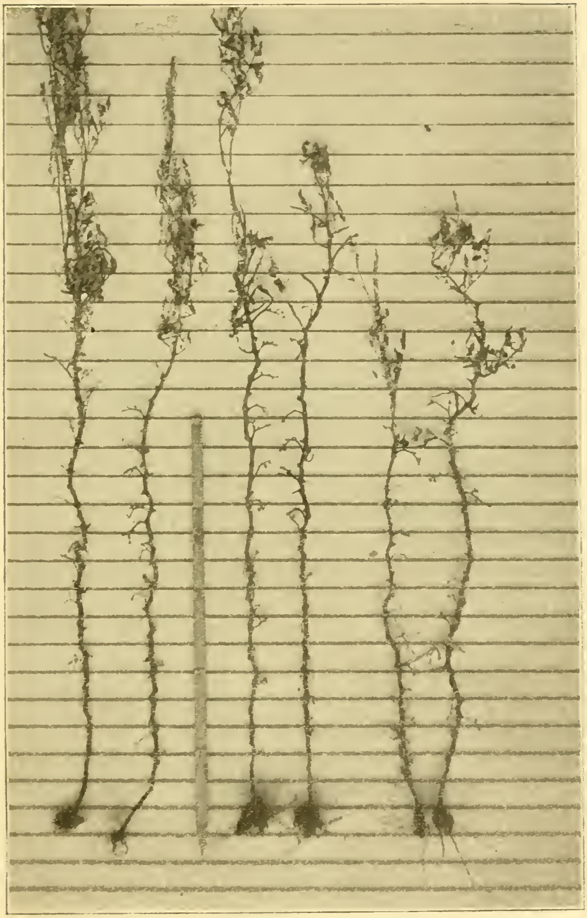
The wooden strips that we prefer are made by stripping up an ordinary inch board of the desired length into about threefifths inch wide pieces. One end of these strips is stuck in the ground at the base of the plant and the upper end is fastened to wires run along parallel with, and directly over, the rows of tomatoes at the proper height, which in this case was about seven feet. The advantage of the string over a pole or strip in training pole beans, etc., is less shade; but with tomatoes we find a more substantial support is quite necessary.

The training of the dwarfs to one stem is easily accomplished. All side shoots are pinched off as soon as they appear, and the top or leading shoot only allowed to grow, thus overcoming the dwarfing tendency to some extent. If this practice is adhered to the plants will continue to grow to a great height. We had no trouble in running them to the height of our houses averaging seven feet or over. These dwarf tomatoes trained in this manner proved to be the most interesting feature of the greenhouse crops during the past season. Not only the amateur gardener but experienced greenhouse men found it hard to believe that the tall plants before them were really dwarf varieties. Several tried to account for the freak through a mistake in the seed used, etc., but upon showing them the different varieties and explaining the method of training they were easily convinced.

It is necessary to do considerable pruning with the dwarf tomatoes. They naturally produce a very dense foliage and in order to let in the light we cut away many of the outer and older leaves and cut back others. As the fruit ripens and the plants get older there is a tendency for some of the first leaves to begin to turn yellow in which case they are picked off.

There is a strong tendency among the dwarfs to send out a new branch from the end of the fruit cluster usually after the fruit has set. This shoot should be cut off as soon as started; otherwise it acts the same as a branch, and, too, the strength is needed for the fruit.

It so happened that through an accident or mistake the top or leading shoot of two of the vines was nipped out and it was interesting to note that these vines simply remained dormant in size but apparently healthy throughout the experiment. The leaves took on a deep green, glossy color, but the plants started no adventitious buds for either fruit or branches.



Lacross Seedling. *Dwarf Champion.* *Golden Dwarf Champion.*
FIG. 3. Old vines, showing the fruit spurs. Part have fallen off.

The main value of the dwarf when trained in this manner as compared with the tall-growing or standard varieties is thought to come from the fact that the dwarfs are shorter jointed and they produce their fruit clusters much closer together on the stem. The average distance apart of the fruit clusters on the average standard is nearly double the distance of that on the dwarfs. This fact taken into consideration together with their slow growth, not reaching the glass so quickly, is a point in their favor. An accompanying figure shows the relative closeness of the fruit spurs.

Two plants of each of the dwarf varieties grown in the greenhouse were trimmed and photographed to show these characters. It may be said that these are old plants at the close of the experiment, and some of the old fruit spurs have fallen off. Enough remain, however, to demonstrate their characteristic growth.

Pollination —The first flowers to appear need artificial aid to enable them to set. Later when there are many in blossom and the atmosphere is kept dry during the brighter part of the day pollination is accomplished by simply tapping the plants. From our own experience we are of the opinion that for results hand pollination is far preferable. It takes considerable time to do the work well, but this brings results. Where artificial hand pollination is carried out nearly all the flowers set their fruit and the fruits are thought to run more uniform in size and appearance. There are various ways of pollinating the flowers. A common one is to collect the pollen by knocking it from the flower and catching it in a watch glass, spoon, etc., and then dip the stigma of the flowers into it. A method that I have found satisfactory and which seems to recommend itself is to take the corolla from the flower just as soon as it begins to lose its bright yellow color and by cutting it along one side and turning it inside out the pollen is exposed and is readily brought in contact with the stigma of the same or other flowers. By taking hold of the tip of one of the petals and giving it a slight twitch the whole corolla loosens about the base of the pistil and slips off over the same. The stamens are attached to the base of the corolla and come off with it. By this simple method no receptacle is needed to catch the pollen and the whole thing is accomplished by the simple manipulation of the fingers. The pistil of the flower from which the corolla is removed is not injured in the least and goes right on developing its fruit. This simplifies pollination and any one can do the work easily. One blossom usually contains enough pollen for a number of flowers. It is difficult sometimes to set the fruit on the first blossom that appears but usually by the time this one begins to lose its color many other flowers have blossomed and these are pollinated by the first one.

Varieties and Yield.—Three varieties, viz.: Dwarf Champion, Golden Dwarf Champion, and Lacross Seedlings were used in the experiment. It seems hardly necessary to go into a detailed description of these fruits, as everyone is more or less familiar with the dwarfs as a class and they all resemble one another in their general behavior of growth. The Dwarf Champion doubtless is as well known as any variety of tomato grown.

In order to compare their relative yields and to demonstrate what can be accomplished in growing them, notes were taken which are compiled in the following tables:

TABLE I.—GENERAL AVERAGES OF VARIETIES.

VARIETY.	Average number fruits per plant.	Average weight fruit per plant.	Average weight of individual fruits.
		lbs.	ozs.
Dwarf Champion	$28\frac{1}{3}$	5.4	3.0
Golden Dwarf Champion	$19\frac{7}{9}$	4.3	3.5
Lacross Seedling	$26\frac{3}{11}$	5.6	3.4

As the dwarf tomatoes continue in bearing for a long time. in order to show their yield at different times I have divided the time into three periods as shown in Table II.

TABLE II.—YIELD IN PERIODS.

VARIETY.	No. plants.	1st period. Weight fruit to May 1st.	2d period. Weight fruit May 1 to June 15.	3d period. Weight fruit June 15 to July 15.	Total weight each variety.
		lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Dwarf Champion	18	34-9	50-7	13-0	98-0
Golden Dwarf Champion	18	11-7	34-6	34-3	80-0
Lacross Seedling	22	31-4	45-12	47-6	124-6
General total	58	77-4	130-9	94-9	302-6

In order to compare the dwarfs with the standard or tall varieties, the following extract is taken from a summary of extended experiments made by Munson :*

"Some varieties seem specially adapted for culture under glass, while others fail to give satisfactory results. Why this is so we do not know; but for the purpose of determining the most promising, we have grown several of the best known varieties for several seasons. Naturally, as the days grow longer in April and May the fruit will be of larger size and the product per plant will be greater than in the case with the first crop in January and February. The figures given below represent the average results obtained, including both crops, for several seasons. Several other varieties—including Ignotum, Perfection, Peach, Prelude, Dwarf Champion, etc.—have been grown, but those named in the table have proved most satisfactory:"

VARIETY.	Average number fruits per plant.	Average weight of product.	Average weight of individual fruits.
		lbs.	ozs.
Chemin Market	12	2.29	3.0
Golden Queen	12	2.22	3.8
Ithaca	11	1.69	2.5
Long Keeper	10	1.86	3.0
Lorillard	13	2.05	2.7
Optimus	13	1.96	2.5

The foregoing data come from one who has made repeated experiments, not only with varieties, but methods of culture, selection of seeds, soils, fertilizers, etc.; hence it can be relied upon. These results, if anything, are high as it is claimed by the writer that without bottom heat and upon ordinary greenhouse beds a much less yield is produced. The latter condition more nearly represents those of our own. The above yields were from boxes with bottom heat and trained to one stem.

Comparatively speaking, therefore, our crop with the dwarfs practically doubles that of the standards for one crop in the spring, or on the other hand produces as much and more from the one continuous fruiting than is yielded by two crops of the tall varieties.

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* Report of the Maine Experiment Station for 1894.

It may be said, however, that it is possible that our dwarf varieties have a slight advantage in that they represent 2¼ square feet of soil, while those of the tall-growing varieties are said to range from 1½ to 2 square feet. By starting the plants much earlier and allowing the dwarfs the entire use of the beds as is the case with the two crops of tall varieties it is believed the dwarfs will more than sustain their reputation. That the dwarf tomatoes are more profitable at least for a second crop there can be little question.

Distance to Plant.—The distance that is best adapted for planting dwarf tomatoes to be trained to one stem seems to be 18 inches each way. By planting them this distance and doing considerable pruning the plants do very nicely. The leaves are large and heavy and obstruct much light unless well pruned. This was the distance the trial varieties were given, and it proved very satisfactory.

Insects, *Fungus*, *and Pests*.—There are many things liable to break out and cause more or less trouble, but most of these are easily handled if taken in time, or better if anticipated and kept away. The only serious trouble that we had to contend with the past season was an attack of Aleyrodes. Other common names of this insect we find are "White-flies," and "Mealy Wings." They are very small, white flies. We paid no attention to them at first as they did not seem to be doing any trouble. They did not appear until late in the season but kept increasing in numbers until at the end they were seriously affecting the plants. The adults deposited eggs on the under side of the leaves which hatched into louse-like nymphs which adhered very closely to the leaves and evidently sucked out much of the sap of the plant. We attempted different methods of spraying with kerosene and water at different strengths. If taken in time this doubtless will prove a satisfactory remedy but our experiment was about over and the plants were pulled and destroyed. We predict this insect would prove very destructive if it should become well established early upon a crop.

Marketing.—In New England tomatoes are sold almost entirely by the pound. It is a difficult matter to give any definite price. In late fall and early spring 25 cents a pound is a popular price for greenhouse tomatoes. During the winter they range higher according to the supply and nature of the season.

SUMMARY.

1. Dwarf tomatoes when trained to one stem are believed to have great merit as a greenhouse crop.

2. The requisites for forcing dwarf tomatoes under glass are practically the same as for the tall-growing varieties; a night temperature of not less than 60° with 70° or more during the day. The soil should never get very dry, and the house, as a general thing, should be kept moist.

3. The house adapted for forcing dwarf tomatoes, trained to one stem, should have considerable space overhead, ranging about eight feet.

4. Almost any good fertile greenhouse soil is good for dwarf tomatoes. Add liquid manure as the plants continue to bear.

5. From data at hand the dwarfs come to maturity fully as early as the tall-growing or standard tomatoes, and on account of their dwarf habit continue in bearing for a much longer period with equal productiveness before reaching the glass.

6. All three varieties tested did well; named in order of productiveness in the test, they were as follows: La Cross Seedling, Dwarf Champion, and Golden Dwarf Champion.

7. A rather stiff trellis, like that made from narrow board strips, is believed to be preferable to cord or string trellis for training the dwarf tomatoes.

8. Hand pollination is thought necessary for best results. The new method adopted by which the corolla and stamens are removed and used to pollinate directly, is believed to save much time and simplify the work of hand pollination.

9. Where tall-growing varieties of tomatoes like the Lorillard can be made a success, dwarf tomatoes under similar conditions and trained to one stem, we believe, will be found much more productive, area for area, and hence more profitable, when time is taken into consideration.

Apple Leaves Eaten by Canker-worms.

REMEDIES FOR THE CANKER-WORM

BY CLARENCE M. WEED

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

DURHAM

Bulletin 85 **October, 1901**

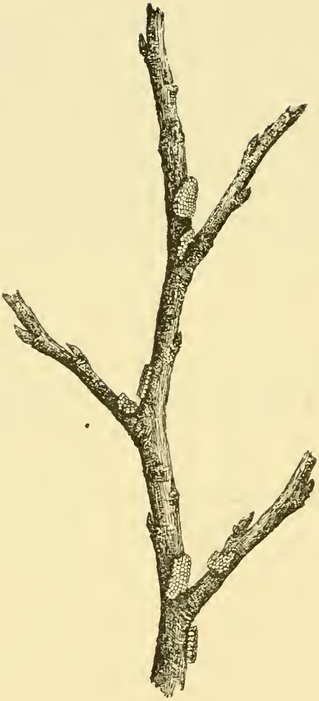

FIG. 2.—Egg-masses of Canker-worm on elm twig.

REMEDIES FOR THE CANKER-WORM

BY CLARENCE M. WEED

During the last two or three years an increasing injury has been done to many orchards in New Hampshire by the canker-worm. This injury is so serious, and might be prevented with such comparative ease, that this bulletin is issued to give the orchardists of the state the latest information concerning methods of combating the pest.

The remedial measures to be used against any insect can best be understood when we know in some detail the life-history of that insect. This is particularly true of the canker-worm, because one of the practical methods of fighting it is dependent upon a peculiar fact in its life-history.

In briefest summary the story of a canker-worm's life is this: In early spring, about the time the leaves begin to push out from the buds, it hatches from an egg previously laid upon the bark of a twig or branch by a small, wingless moth. The little canker-worm immediately begins to feed upon the green and succulent tissues of the young leaves, a process which it continues from day to day for about a week. It then is too large for the skin with which it was born, and so it moults or sheds its skin, crawling out of the old one, clothed in a new one that had been formed beneath the other. It soon begins feeding again, eating more and more of the green tissues of the leaf as it grows larger. About a week later this moulting process is again repeated, after which the caterpillars continue feeding as before. In the course of five or six weeks of such growth the canker-worms become full grown so far as this caterpillar state is concerned.

When thus full grown the canker-worms are green or brown, varying much in color, more or less striped with longitudinal lines. On the under side of the body are ten legs, six just back of the head, and four near the hind end. In moving about, the middle of the body is humped up, and in consequence these insects are commonly called looping caterpillars or measuring worms. When the branch upon which the insects are feeding or resting is jarred, the canker-worms drop toward the ground, each spinning from its mouth a silken thread, up which it can crawl again when danger passes.

Late in spring or early in summer the full-grown canker-worms descend to the ground, where, at or slightly beneath the soil surface, they make slight silken cocoons. Within these they change to chrysalids or pupæ, remaining in this condition until the autumn or spring following. Then they emerge as small, grayish moths.

There is a remarkable difference in the appearance of the sexes of these moths. The males (Fig. *e*) have small bodies and broad, well developed wings; the females (*d*) have large bodies but no wings. While the former can fly freely the latter can only crawl up the neighboring trees to deposit their eggs; they die soon afterwards. The eggs hatch when the leaves begin to expand in spring and the young worms begin their ruinous work.

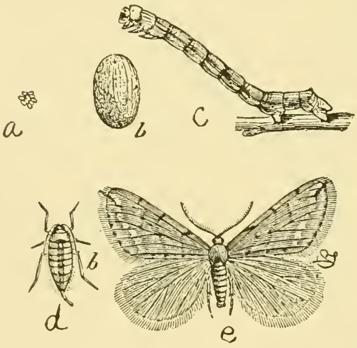

FIG. 3.—The spring canker-worm: *a*, egg mass, natural size; *b*, egg, magnified; *c*, larva; *d*, female moth; *e*, male moth. (After Riley.)

Those who have studied the canker-worms most carefully have found that there are two common species—the Fall Canker-worm (*Anisopteryx pometaria*) and the Spring Canker-worm (*Paleacrita vernata*). The moths of the former species appear and lay their eggs mostly in autumn, while those of the latter (Fig. 3) appear in spring. Both species are found in New Hampshire, the spring species being apparently the more destructive at the present time.

REMEDIAL MEASURES

The two practical remedial measures which may be used against the canker-worm, are the banding of the trees to prevent the ascent of the moths, and the spraying of the leaves with poisons to kill the worms. The success of the first is due to the fact that the egg-laying female moth is wingless and that she becomes fully developed on or beneath the surface of the ground: consequently to lay her eggs upon the twigs she must ascend the trunk of the tree.

Various substances have been used in the past for this banding of the trees, printer's ink being, perhaps, the most popular of these. The best thing now available, however, is the substance called Bodlime made by the Bowker Chemical Company of Boston, Mass. This is a thick, pasty material which may be put directly upon the bark of the trees in a wide band which will remain fresh and in position for months. The manufacturers say that "the band should be from two to two and one half inches wide, and from one half to three fourths of an inch thick at the lower edge. Bevel off the upper side of the band to the bark to shed rain water, and bring the lower side to a sharp edge. The banding is best done on a moderately cold day, using a common, smooth blade trowel for spreading and shaping the band. Working the mixture over with a trowel softens it." The manufacturers also give the following

CAUTION

"Do not apply Bodlime to young, thin barked trees. In this case it is best to spray. Remove all bands as soon as the danger from the canker-worm is over. *This is important.* Keep packages closed when not in use to avoid evaporation."

Last spring I had an opportunity to observe a practical test of this substance in the orchards of Mr. Albert Demeritt of Durham. The results seemed to me to be very satisfactory and Mr. Demeritt has kindly written for this bulletin the following account of his experience with the remedy:

"In reply to your query regarding my use of 'Bodlime' on my trees in the spring of 1901, I would say that my trees are very large trees, and as I have to hire all my work done I had the 'Bodlime' applied by a man who was an expert in the use of the trowel. I ordered material sufficient for 200 trees and they sent me 200 lbs. which cost $15, on cars in Boston. The freight charges and the labor charges brought the cost per tree up to about ten cents per tree. We removed the 'Bodlime' about July 1, as you recommended. It seemed to be very effective, so much so that we shall not apply it to our orchard next year. The application was made April 1 and 2. This was just a little too late, in my opinion, as some of the moths had gone up before the application was made. However, I think it was effective enough so that I shall not make the application the ensuing year. If the canker-worms show any in the orchard in the year 1902, I shall make two applications of 'Bodlime'—one about Nov. 1, 1902, and the next March 15, 1903. I shall put a little higher than the bands where the 'Bodlime' was applied the previous November. I was obliged to make daily examinations of the bands of 'Bodlime' to take off the moths that were caught each night to prevent their bridging the bands with their dead bodies."

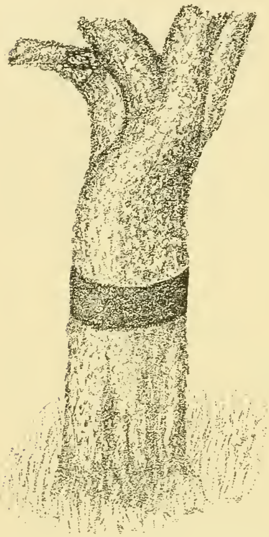

FIG. 4.—Tree trunk showing method of banding.

This banding method is particularly serviceable in the case of orchards which are likely to be badly infested, because it prevents the injury that is bound to occur before the canker-worms in such an orchard can be killed by spraying. It also is especially useful in protecting large elm trees, which are difficult to spray on account of their height.

If thoroughly applied, the bands being kept on throughout the entire season, during which the moths and caterpillars of both species appear—from October till June—this banding method is easily applicable to orchard practice. In cases where the attack the previous season was severe, it will generally pay to apply the bands, even if the orchardist expects to spray his trees, for as intimated above, it has been the general experience that an orchard badly infested by canker-worms cannot be wholly freed from the pests the first season, before considerable damage is done to the foliage. Some New Hampshire farmers have told me they preferred to fight the canker-worm by the banding, rather than the spraying, method, because their other work kept them so busy during the spraying season. But, in general, the orchardist will find it profitable to spray, because he can thus kill off not only the canker-worms and other leaf-eating insects, but the codling-moth as well, and if he so desires, he can in the same mixture fight the apple scab and other fungous diseases.

The spraying method of fighting the canker-worms aims to cover the leaves with fine particles of poison so that the young worms will eat it and be killed. When an orchard is infested by canker-worms it is very desirable to spray once before the blossoms open. The insects begin hatching early in the season; if trees are not sprayed until after the blossoms fall considerable damage will be done before the worms are killed. One spraying when the buds are in the condition represented in Fig. 5 will be of much service. Another should be given as soon as the blossoms fall; and if the canker-worms are very numerous a third—a week or ten days after the second—will be desirable.

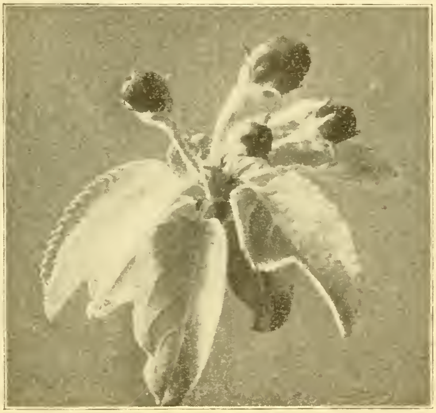

FIG. 5.—Apple Buds.

The spraying may be done either with Paris green, Scheele's green, or arsenate of lead. Paris green may be applied in a water spray at the rate of one pound to two hundred gallons of water, with a pound or two of fresh slacked lime added to each barrel of the mixture to render all the arsenic insoluble, and thus prevent injury to the foliage.

If arsenate of lead is used it should be bought in the form of a paste, and may be used at the rate of three pounds to fifty gallons of water. This poison has these advantages over Paris green: (1) There is no danger of burning the leaves, so that it can be put on in stronger mixture; (2) it remains in suspension in the water better; (3) it adheres to the foliage more evenly and longer; (4) it may be seen upon the leaves more readily so that the thoroughness of the spraying may more easily be determined.

Scheele's green is another arsenical insecticide recently placed on the market. According to a bulletin of the United States Department of Agriculture, it "is similar to Paris green in color, and differs from it only in lacking acetic acid; in other words, it is a simple arsenite of copper. It is a much finer powder than Paris green, and therefore more easily kept in suspension, and has the additional advantage of costing only about half as much per pound. When properly washed and prepared by the manufacturers it is less harmful to the foliage even than Paris green, is quicker in effect, and should supplant the latter as an insecticide. It is used in the same way and at about the same strength as Paris green."

COST OF THE CHEMICALS

Arsenate of lead costs from fifteen to twenty cents a pound, according to quantity purchased. Scheele's green costs about ten cents a pound, and Paris green about twenty cents a pound. All of these substances may be purchased through dealers in insectides, the large drug firms, the seed houses, or of the manufacturers of chemicals.

There are many sorts of good spraying pumps now upon the market; they may be purchased through any hardware dealer or seedsman. The spray should be applied through a nozzle that throws a fine mist, and should be evenly distributed over the tree, stopping just before the leaves begin to drip.

Bulletin 86 November, 1901

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

I. GROWING WATERMELONS IN THE NORTH

II. CLASSIFICATION OF WATERMELONS

Ironclad

BY F. WM. RANE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

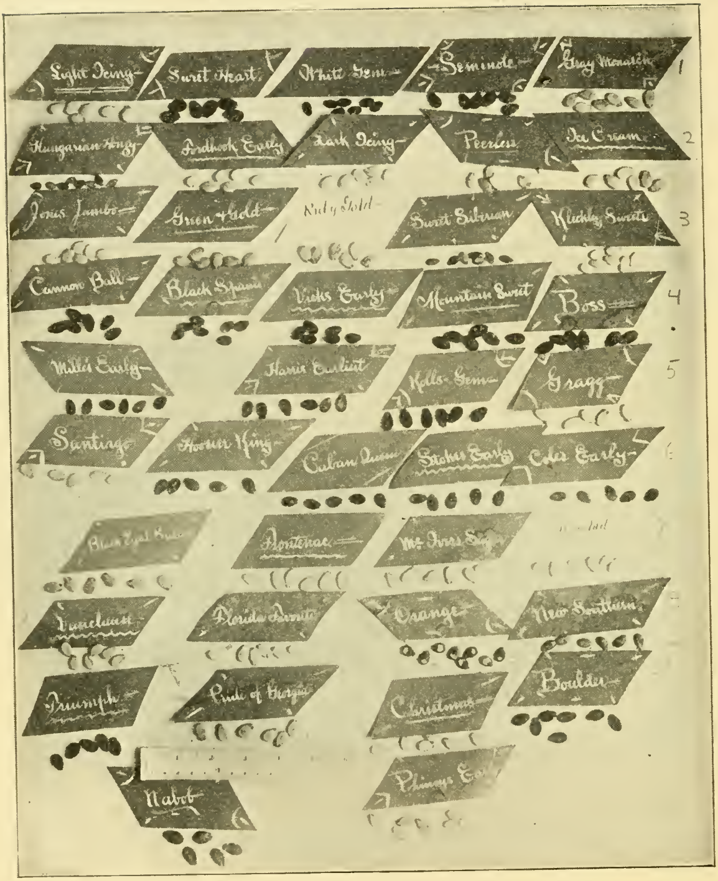

FIG. 2.—Color and size of the seeds of various varieties of Watermelons.

THE WATERMELON

BY F. WM. RANE

The watermelon (*Citrullus vulgaris*) is a native of Africa, and needs little introduction to the average reader. Its popularity as a cool, refreshing, and satisfying fruit during the hot summers of the temperate zone has so increased that the area devoted to its culture can hardly be estimated. Thousands of acres of watermelons are grown in a commercial way, the larger part being in the South. There are hundreds of farmers who grow them in a small way, however.

Very little has been written on the watermelon. The small treatise published by W. Atlee Burpee, "How to Grow Melons for Market," one-half of which is devoted to the watermelon, and Bulletin No. 38 from the Georgia Experiment Station, together with casual short articles found here and there in text-books and bulletins, comprises about all the available literature. The following discussion of the culture of the watermelon, together with its classification under Part II, is given with the hope that this bulletin will be of general usefulness.

I.

GROWING WATERMELONS IN THE NORTH

We little appreciate the possibilities of the watermelon as a crop well adapted to grow in Northern climates. The customary idea is to think of this fruit of the vine as only at home when in a warmer climate. The Southern grower places them at our doors very early in the season, and it is from this source that we have gotten into the habit of looking for our supply throughout the summer season.

During the past few years the writer has given much attention to growing the watermelon here in New England, and has met with such marked success that it is thought our results cannot help from being of general interest. At first it was hoped that by a careful study of varieties we might find one that would mature early. Here and there at fairs could be found a person who had fairly good specimens, but the general idea seemed to prevail that these were accidents rather than otherwise. Our experience at the experiment station seemed to show that most of the varieties planted matured each season. One gardener was found who was making a very marked success in growing the variety known as Cole's Early. His success, which extended over a period of years, not only in growing them successfully but in marketing them with profit, led the writer to undertake a general test of many varieties, also a study of methods of culture, soils, classification, etc.

During the winter of 1899–1900 seeds of a large list of watermelons were secured from various sources, making in all forty-six (46) varieties.

In the spring of 1900 arrangements were made with Mr. Harry F. Hall of Gonic, N. H., the gardener above referred to, to coöperate with the experiment station in carrying on the test of varieties and other experiments desired in this connection throughout that season.

Mr. Hall's marked success in growing the watermelon for a number of years on a field scale is thus embodied in this report as the basis for success. His methods were closely followed, and it is from his experience largely, as well as personal observation and note taking, that the foundation of this bulletin is formed. Four new varieties in addition are reported for the past season.

1. CULTURE

(a) *Soil and Location.* The experimental patch upon which the melons shown and described in this bulletin were grown was prepared by plowing under a heavy application of coarse, strawy stable manure the preceding fall. The field was an old, sandy loam pasture, with an easterly to southern exposure. In the spring the ground was replowed the last week in April and harrowed every week until planted the 22d of May. This destroyed many of the weed seeds contained in the top soil, and also left the ground very light and friable, which is quite an important consideration. Mr. Hall claims that with this preparation the plants send out good runners and feeders, which are needed for success.

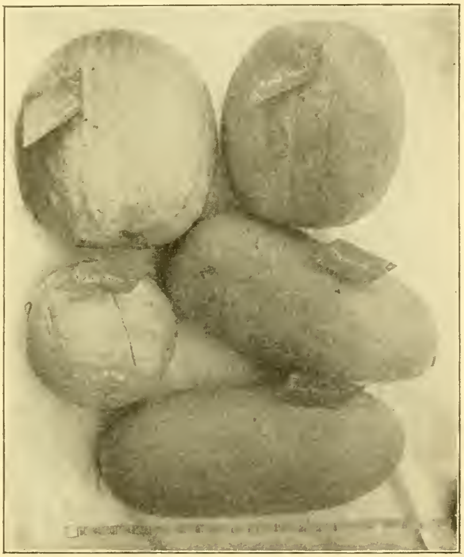

FIG. 3.—Light Green Watermelons.

Light Icing. Sweet Heart.
White Gem. Seminole.
Gray Monarch.

While watermelons may be grown on almost any soil, excepting, perhaps, a heavy clay one, they thrive best on a rich, warm sandy loam, that is well supplied with humus. A southern slope is preferable, although not necessary for success, as it hastens maturity and furnishes early natural drainage, which is very essential, especially in a cold and wet season.

(b) *Planting.* The best planting date for southern New Hampshire has been found to be from the 20th to the 31st of May. The fact that the watermelon vines are tender and quickly stunted by the cold when small, should always be remembered by the New England or Northern grower.

The preparation of the hills, which are ten feet apart each way after Mr. Hall's practice, is as follows: Fill the hills, which should be dug 8 or 10 inches deep and 18 to 24 inches in diameter, two-thirds full with a rich, well-rotted manure.

He prefers a good stable manure that has been piled up over winter and thoroughly chopped over, with a small quantity of hen manure and sand added. Enough soil is drawn on this and thoroughly mixed with the compost to fill the hill nearly full. A half pint of unleached wood ashes, or fine hen manure, or a small handful of phosphates, is sprinkled over the top soil and well mixed with it, after which enough soil is added to make the hill level with the top of the ground. The hill is now ready for the seed. The seed should be from a reliable source. Ten or twelve seeds should be planted in a circle, about one foot in diameter, in the centre of each hill; then draw on from one-half to two-thirds of an inch of fresh, moist soil, and press it down firmly with the hoe; also, add lightly from one-fourth to one-half inch of loose dirt, to act as a mulch. When the seeds germinate, and as soon as the plants begin to run, or after all danger from insects is past, thin to two or three plants, leaving the thriftiest in each hill.

(c) *Cultivation.* Mr. Hall begins cultivation as soon as the plants are well up. This work is done deeply and thoroughly, and is repeated as often as necessary to keep the ground mellow and free from weeds. It is especially important after a rain to loosen the soil around the young plants in order to prevent the surface from becoming hard and crusty. After the vines begin to run, the cultivation is best to be shallow. Remove by hand all weeds appearing after the vines have covered the ground. When cultivating be careful not to step on or injure the vines in any way, as they are very tender.

After the vines begin to run, and before the melons set they will sometimes be blown around and badly injured by a strong wind. To prevent this, draw a little loose dirt over the vines every two or three feet until the fruit is large enough to hold them.

(d) *Enemies.* One of the worst enemies of the watermelon is the small striped cucumber beetle. This is the small yellow beetle with black stripes on his back that so commonly attacks squashes, cucumbers, melons, etc., soon after they come up. It delights in eating the cotyledonous, or first, leaves of the plant, and if they are not checked by preventative measures the plants cannot be grown. The remedies for this insect are to drive them away by covering the young plants with a light sprinkling of some of the following substances: tobacco dust, ashes, ground bone, plaster, or lime. These beetles usually appear suddenly, and it is necessary to keep an eye on the field or patch to prevent their doing damage before discovery.

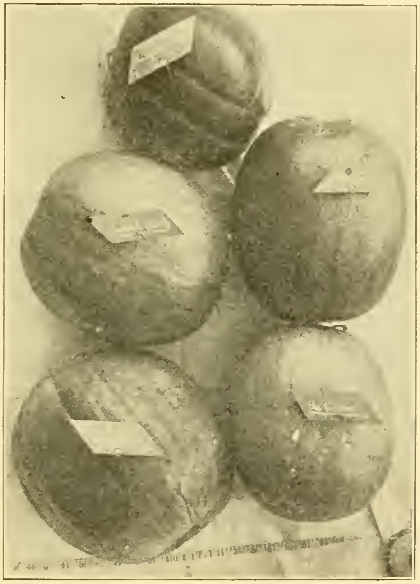

FIG. 4.—Medium Green Watermelons.
Hungarian Honey.
Fordhook Early. Dark Icing.
Peerless. Ice Cream.

Cut worms are sometimes troublesome, but are easily found and should be killed upon first sight. If in large numbers they are destroyed by strewing poisoned baits of clover, grass, cabbage, etc., about the patch. Watermelons are sometimes troubled with an aphis, the remedy for which is kerosene emulsion. Fungous diseases can be controlled by means of the Bordeaux mixture.

(e) *Picking.* The watermelon begins ripening during August in New England, and continues in bearing until frost kills the vines. A sign of ripeness in some varieties is the dying of the curl on the vine opposite the melon; while in some others the skin resting upon the ground changes from a light green to a dull yellow. Experts generally test the ripeness by snapping the melon with the middle finger. When this is done on the ripe fruit the sound is like that made by striking a cask full of water, while the sound from a green melon is more like that given off when striking an empty cask. Another test is to press the melon with the palm of the hand, at the same time bringing it close to the ear. If it has any tendency to yield, or a slight cracking of the flesh can be heard, it is usually ripe. A green melon will remain hard and firm.

(f) *Storing and Marketing.* The quality of the watermelon is finer if gathered in the morning when cool; the fruit will also keep in better condition. Melons picked at the proper time, carefully handled, and stored in a cool cellar, will keep from four to six weeks.

The best melon for home use or the general retail trade in New Hampshire is a medium-sized variety with a thin rind, red flesh, early, and extra sweet, weighing from twelve to twenty-five pounds. Market gardeners who have not attempted growing this crop can little realize what can be accomplished in the way of building up a good trade with this fruit. The home-grown melon, fresh from the field, will recommend itself. We have had men test them who have been born and raised in the South, who pronounced them as highly flavored and delicious as any they had ever tasted. The markets are very good, and the fruits sell readily at from one to two cents a pound.

2. VARIETY TEST

The following list of 51 varieties was planted under similar conditions and each given the same treatment. The methods of culture already described constitute the exact treatment given this test throughout.

The accompanying table is a condensed tabulation showing the results of the experimental comparative test of each variety. For a better idea of the form and general appearance of each variety see the various photographs. The basis for comparison in the table is the product of two hills of each of the varieties. The color and size of the seeds from each variety are shown in an accompanying photograph. All of the varieties have red flesh excepting those marked with an asterisk (*), which are either yellow or cream color.

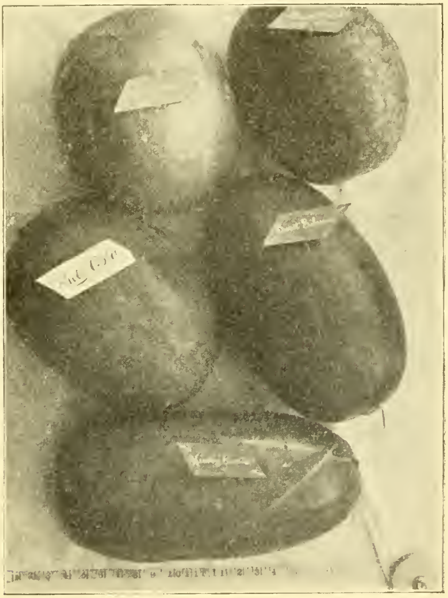

FIG. 5.—Medium Green Watermelons.
Jones' Jumbo. Green and Gold.
Ruby Gold. Sweet Siberian.
Kleckley Sweets.

Number.	Variety.	No. of melons ripened over 6 lbs.	No. ripe Sept. 1st.	Aver. weight lbs.	Shape.	Thickness of rind.	No. of fruit per acre.
1	Light Icing	7	2	15	Oval	⅔ in.	1854
2	Sweet Heart	7	5	19	“	⅔ “	1854
3	White Gem	8	5	9½	Round	½ “	2126
4	Seminole	7	0	14	Long	⅔ “	1854
5	Gray Monarch	7	1	16	“	½ “	1854
6	Hungarian Honey	8	6	10	Oval	½ “	2126
7	Fordhook Early	6	4	17	“	⅔ “	1582
8	Dark Icing	6	2	16½	“	⅝ “	1582
9	Peerless	7	4	17	“	¾ “	1854
10	Ice Cream	7	3	16	“	⅝ “	1854
11	Jones' Jumbo	4	0	14	“	¾ “	1063
12	Green and Gold*	4	0	15½	“	⅝ “	1063
13	Ruby Gold*	5	0	19	“	⅝ “	1335
14	Sweet Siberian *	6	4	14	Long	½ “	1582
15	Kleckley Sweets	5	2	19	“	½ “	1335
16	Cannon Ball	7	4	7	Round	½ “	1854
17	Black Spanish	7	4	17	Oval	1 “	1854
18	Vick's Early	5	4	10	Long	½ “	1335
19	Mountain Sweet	6	2	16½	“	⅝ “	1582
20	Boss	8	5	19	“	⅝ “	2126
21	Mills' Early	7	5	13	Oval	½ “	1854
22	Harris' Earliest	6	5	15	“	⅞ “	1582
23	Kolb's Gem	6	3	16½	“	⅝ “	1582
24	Gragg*	5	0	17	“	⅝ “	1335
25	Santiago	5	0	22½	Long	¾ “	1335
26	Hoosier King	5	1	17½	Oblong	½ “	1335
27	Cuban Queen	4	2	21½	“	⅝ “	1063
28	Stokes Early	5	4	15	Oval	⅝ “	1335
29	Cole's Early	8	6	20	“	⅞ “	2126
30	Delaware	7	0	11	Oblong	⅝ “	1854
31	Dixie	7	1	18	Long	⅝ “	1854
32	Rattlesnake	6	0	12	“	½ “	1582
33	Black Eyed Susan	6	3	18½	“	½ “	1582
34	Frontenac	7	2	16½	“	½ “	1854
35	McIvers' Sugar	4	0	16½	“	⅝ “	1063
36	Ironclad	5	1	23	“	⅝ “	1335
37	Triumph	5	1	13	Oval	¾ “	1335
38	Pride of Georgia	6	1	12	“	½ “	1582
39	Christmas	6	0	14	Oblong	¾ “	1582
40	Black Boulder	6	2	25	“	⅝ “	1582
41	Vauclause	5	2	16½	Long	⅝ “	1335
42	Florida Favorite	4	0	15	“	¾ “	1063
43	Orange	7	2	11½	Oblong	⅝ “	1854
44	New Southern	4	0	19	Long	⅝ “	1063
45	Nabob	4	0	20	Oval	1 “	1063
46	Phinney's Early	7	5	18½	Oblong	¾ “	1854
47	Jones	0	0	6	.....	.....	.....
48	Jackson	.....	.....	19½	Long	¾ “	.....
49	Golden Gate	.....	.....	16¾	Oval	1 “	.....
50	Early Corona	.....	.....	20½	“	½ “	.....
51	Paul's Bonny Best	.....	.....	.....	“	.....	.....

3. DESCRIPTION OF VARIETIES

Black Boulder.—This new dark green melon originated in New Jersey. Size, uniformly large. Medium early, flesh bright red and sweet. Rind tough making it desirable as a shipper. Oval in shape. Seeds nearly black. Sometimes this variety has a tendency to dull stripings.

Black Spanish.—Shape perfectly round. Medium size, color nearly black. Solid red flesh of good quality. Seeds brown. Matures early and is quite prolific.

Black Eyed Susan.—A new Southern melon that promises well for Northern culture. Shape oblong to long, light stripings, thin, tough rind, quite early, solid scarlet flesh of extra quality. Seeds white, with two dark spots at the sprout end.

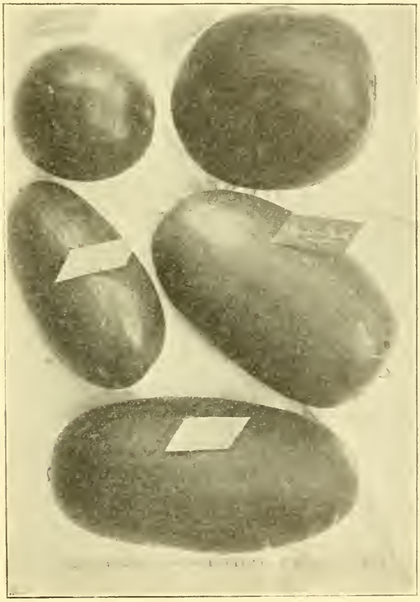

FIG. 6.—Dark Green Watermelons.

Cannon Ball. Black Spanish.
Vick's Early. Mountain Sweet.
Boss.

Boss.—A long, dark melon, very heavy for its size. Flesh solid, red and of the best quality. Seeds black. A good all-round melon for the North.

Cannon Ball.—A small, round, dark green melon, early and good quality, but too small to grow for market. Black seeds.

Christmas.—A small, late, oblong, dull striped melon; of fair quality and noted as a good keeper. Seeds white.

Cherokee Beauty.—See New Southern.

Cole's Early.—Fruit medium sized, round or slightly oval, marked with irregular stripes of dark and light green. Flesh red, solid, and very sweet. Early and reliable. Rind brittle; seeds dark brown. One of the best varieties for New England culture.

Cuban Queen.—A large, showy melon with narrow dark and wide light stripes. Flesh bright red and very solid but rather poor in quality. The melons are fair size, oblong in shape, slightly tapering at the stem end. Seeds dark brown. A good keeping variety.

Dark Icing.—Round, medium green; flesh scarlet, solid and sweet. Rind thin, seeds white. Quite desirable and well known.

Delaware.—Cross between the Ironclad and Mountain Sweet. Oblong shape, beautifully light and dark striped. Flesh a brilliant red, solid, and ripens within 1-2 to 3-4 inch of the rind. It resembles the Mountain Sweet in flavor. The rind is very tough, making it very desirable both for shipping and keeping. Seeds white with brown tips.

Dixie.—A long, dark green melon striped with a light shade. Season medium early, quality fair. Vines hardy and vigorous in growth, seeds dark. A cross between the Kolb's Gem and Mountain Sweet, largely grown in the South for distant markets.

Fordhook Early.—Nearly round, quite early. Color medium green finely mottled; seeds white; flesh light red and sweet. Poor keeper. Highly spoken of by seedsmen.

Florida Favorite.—A rather long shaped melon, striped with dull greens. A cross between the Rattlesnake and Pierson. Seeds white. A shy bearer.

Frontenac.—Long, dark green predominating but striped with light green. Flesh bright red, solid and fine quality. Seeds dark. Although a new Southern variety it promises well in the North, being early.

Gragg.—Quite distinct, medium sized, yellow flesh, oblong, light striped, seeds white with brown tips. Flavor good. Rather late.

Gray Monarch.—The variety is also known as Long White Icing. Long oval shape, very light green. Flesh red and very sweet. Seeds white tinged with brown.

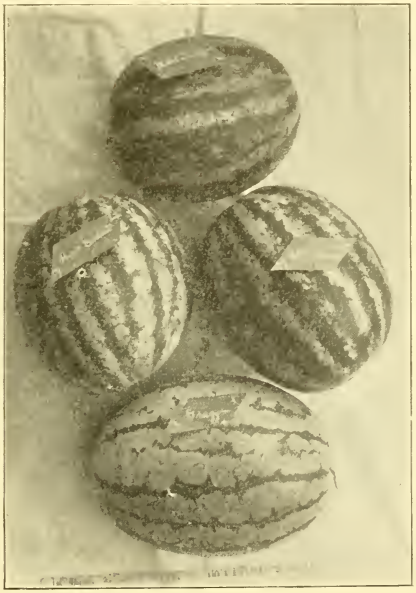

FIG. 7.—Light Striped Watermelons.
Harris' Earliest. Mills' Early.
Gragg. Kolb's Gem.

Green and Gold.—Small, round, medium, green melon with mottled skin. Flesh bright yellow, quality fair, small yielder. Seeds grayish.

Harris' Earliest.—Early of medium size, light striped, nearly round, red fleshed, dark brown seeds. Resembles Mills' Early in every particular.

Hoosier King.—Oblong in shape, light striped resembling Cuban Queen. Flesh bright red and solid. Seeds dark brown. Fine quality.

Hungarian Honey.—Nearly round in form. Color of skin medium green. Flesh bright red, stringless, and very sweet. It has very small seeds of an orange brown color. Early and very productive. One of the best for home use but too small for market.

Ice Cream.—Medium sized, round or nearly so, medium green. Flesh pink and sweet. The largest specimens often grow hollow hearted. White seeds. Some think this the same as Peerless.

Ironclad.—A long light and dark striped melon. Flesh a dainty red, firm and solid; see cut on front of this bulletin. Seeds white. The rind while thin is very tough, making it an excellent keeper.

Jones.—A very late variety, none ripening although a number set.

Jones' Jumbo.—A medium green variety. It is highly spoken of for the South as a good shipper, fine flavor, etc. It is apparently too late for our climate. Seeds white.

Kleckley Sweets.—An early, long, dark green melon. Flesh scarlet, solid and very sweet. Seeds white. Excellent for home use but too brittle for shipping.

Kolb's Gem.—A popular variety largely grown in the South for Northern markets. A cross between the Scaley Bark and Rattlesnake. Nearly round in shape, and light striped. Flesh bright red and of good flavor. Seeds black. A good shipper.

Light Icing.—Medium sized, round or nearly round. Light green skin. Flesh light red, solid, and very sweet. Seeds white.

McIvers' Sugar.—A long melon beautifully striped with light and dark green. Flesh solid, tender, and sweet. Seeds white. An uncertain and shy bearer, from our experience.

Mills' Early.—Similar to Cole's Early except smaller in size. Well adapted for home use in sections where larger melons will not ripen.

Mountain Sweet.—Long, dark green. Flesh red, solid, and sweet. Seeds black. An old but very desirable variety.

Nabob.—Nearly round, mottled, and resembles Phinney's Early except in form. Quality good. Seeds brown. A light cropper.

New Southern.—This variety has been named Cherokee Beauty. A new Southern melon similar to Florida Favorite. Flesh red, solid, and sweet. Seeds black. Color, a dull striped. Medium early.

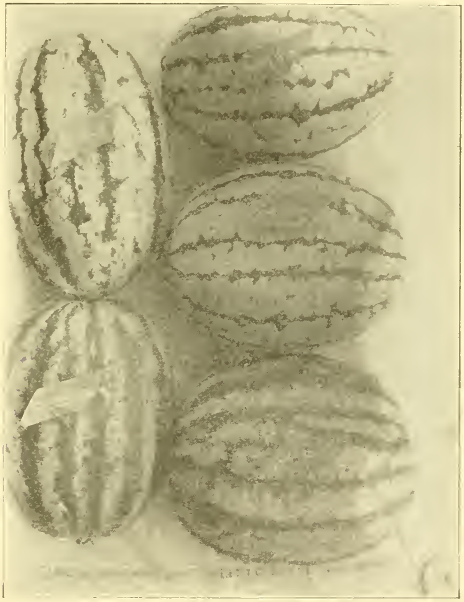

FIG. 8.—Light Striped Watermelons.
Santiago. Hoosier King.
Stokes' Early. Cuban Queen.
Cole's Early.

Orange.—The rind of this variety when ripe separates itself from the flesh. It is interesting as a curiosity. Flesh light red containing black seeds and fairly good quality but rather stringy.

Peerless. Color, medium green. Early, reliable, and productive. Flesh scarlet, crisp, and sugary. A standard variety for New England for market or home use where white seeds are not objectionable.

Phinney's Early.—An oblong melon of medium size, ripening early. White seeds. Flesh pink, and fair quality. The skin is mottled or marbled, being like the Nabob in this respect. Very productive. Poor keeper.

Pride of Georgia.—Round, medium-sized, dull striped. Flesh bright red containing grayish seeds. Fair quality. A popular Southern variety.

Rattlesnake.—Long, beautifully light striped. Very thin rind. Scarlet flesh, solid and medium in quality. Seeds white with brown tips. This is a well-known variety and is also known as Striped Gipsy.

Ruby Gold.—Small sized, color medium green some mottled. Flesh pale yellow containing white seeds; inclined to be stringy. Poor quality and unproductive with us.

Santiago.—Similar to the Ironclad.

Seminole.—Shape long, tapering at the ends. Color light green or gray. Rind thin and tough. Flesh a brilliant carmine containing black seeds. Flavor excellent.

Stokes' Early.—A small, round, light striped melon. One of the earliest, having small black seeds. Flesh red, solid, and of fine quality.

Sweet Heart.—Color light green nearly white. Medium size and quite early. Oval or roundish in shape. Flesh red, solid, and good quality. About twenty-five per cent. rotted on the vines.

Sweet Siberian.—Introduced from Russia. Long, medium green, early, medium sized. Flesh light yellow, very sweet and juicy although somewhat stringy. Seeds small and brown.

Triumph.—A new Southern melon. Cross between Duke Jones and the Kolb Gem. Shy bearer producing small to medium-sized melons of poor quality. Dull striped and round in shape. Seeds black. Apparently not adapted to our climate.

Vick's Early.—An early, small, long, dark green melon. Flesh red, containing black seeds, medium quality. Light yielder.

Vauclause.—Rather long, medium-sized, dull striped melon. Seeds and flesh red. Quality good but poor yielder. Sometimes called Red Vauclause.

White Gem.—Shape perfectly round. Color, cream white with striped water marks. Rind thin and very tough. Seeds black. Flesh solid, quality fair. Quite early. Worthless for market.

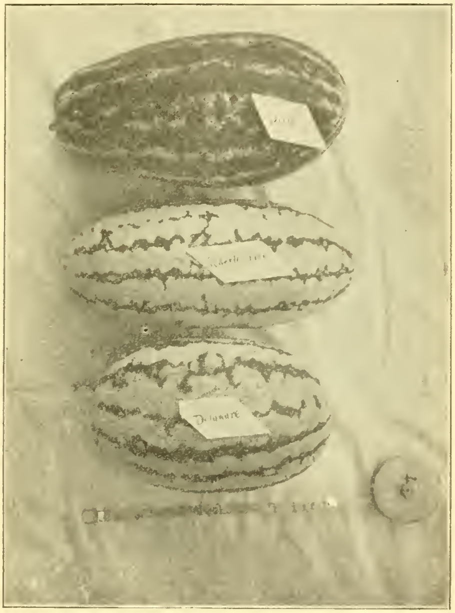

FIG. 9.—Light Striped Watermelons.
Dixie. Rattlesnake. Delaware.

Additions the Past Season.

Jackson.—A long, medium green variety. Flesh firm and sweet, containing small white seeds.

Golden Gate.—This variety comes from California. A medium-sized melon with light and dark green stripings. It resembles the Cole's Early very much. Seeds brownish black. The flesh is somewhat stringy.

Early Corona.—A new variety just introduced the past season. It belongs to the Black Spanish type of watermelons, being a dark green in color and oval in form. Flesh firm, of good flavor, and contains dark brown seeds. It is an early variety of good size and very promising.

Paul's Bonny Best.—A new introduction of the past season. It is early; somewhat smaller than Cole's Early, and perhaps earlier. Light and dark green stripings, oval in form. Quite promising. Our test was incomplete the past season.

II.

CLASSIFICATION OF WATERMELONS

After much study it has been decided to make herewith a classification of the fruit simply. As with the muskmelon, while the leaves, stems, etc., have their various characteristics, and a classification could doubtless be derived from a study of them, the fruit itself is the object in which the mass of people is interested. The fact that certain markets want a certain type of melon, either in shape, size, external appearance, color of flesh, dark or light seeds, etc., goes to show that it would be of great benefit, to dealers in particular, if there were terms which represented the various groups or classes.

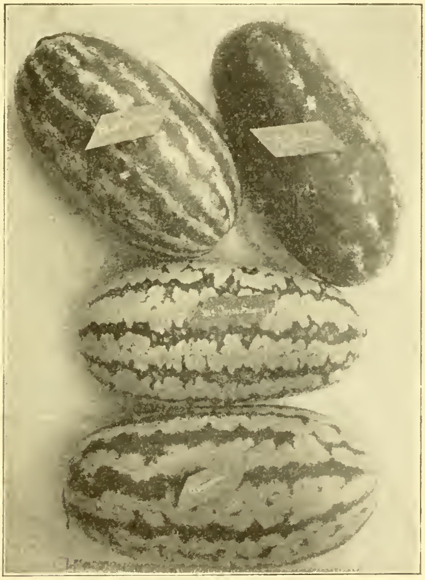

FIG. 10.—Light Striped Watermelons.
Black Eyed Susan. Frontenac.
McIver's Sugar. Ironclad.

Watermelons readily group themselves into six classes based upon the color or characteristics of the skin or external appearance. These are as follows:—I Light green, II Medium green, III Dark green, IV Light striped, V Dull striped, and VI mottled. These classes are again subdivided into groups according to shape of the fruit. These subclasses or groups I have chosen to call types. Each class is liable to have three types according to the shapes of the fruit; for example, 1 round or oval, 2 oblong or medium, and 3, long. To demonstrate:—Class IV light striped, has three types, viz., 1, Kolb's Gem type (round or oval), 2, Cuban Queen type (medium), and 3, Rattlesnake type (long). The other classes are similarly divided into types, although some of the classes did not have over two types present in our test, and hence are so represented.

The practice of indicating each type by naming it according to an already well known variety is thought to at once convey in a general way an idea of the type and its kin.

Each type is again classified according to the color of its seeds,—being either light or dark. Brown seeded varieties are classed with the dark, while those more predominating in white are grouped with the white.

It does not necessarily follow that in the proposed classification the fruit of each variety will all be of the same form to which it is referred; for, as every melon grower knows, the fruits in each hill vary more or less; but if everything is normal and favorable for their development the characteristic form or that typifying the variety will predominate. The larger the experience of the grower, the easier it is for him to understand these various types. In considering the shape we do so regardless of size, although it is the marketable, or fruits that have reached a good size, that are considered. In order to get the true type of each variety, it is important that the seeds be secured directly from the seedsmen who first introduced them, thus avoiding complications or errors.

The predominating color of the flesh of the watermelon is red or some shade of red; hence the comparatively few yellow varieties are indicated by an (*) asterisk in their classification or elsewhere.

Analytical Key

I. Light Green Class	Sweet Heart Type, (oval shape)	Page 98
	——— ——— medium shape)	
	Monarch Type, (long shape)	“ 98
II. Medium Green Class	Icing Type, (oval shape)	“ 98
	——— ——— (medium shape)	
	Jackson Type, (long shape)	“ 100
III. Dark Green Class	Black Spanish Type, (oval shape)	“ 100
	——— ——— (medium shape)	
	Boss Type, (long shape)	“ 100
IV. Light Striped Class	Kolb's Gem Type, (oval shape)	“ 101
	Cuban Queen Type, (medium shape)	“ 102
	Rattlesnake Type, (long shape)	“ 102
V. Dull Striped Class	Pride of Georgia Type, (oval shape)	“ 103
	Christmas Type, (medium shape)	“ 104
	Favorite Type, (long shape)	“ 104
VI. Mottled Green Class	Nabob Type, (oval shape)	“ 104
	Phinney Type, (medium long shape)	“ 105

Sweet Heart Type

This type of watermelon is characterized by its very uniform light green skin, which almost approaches a white in the White Gem variety, and particularly by its round or oval shape. There is little difficulty in classifying this type because it is a matter of color and form regardless of size. Some or most of these varieties, while we speak of their uniform color, show what is termed water stripedness but these stripings are not considered in their classification unless they are well marked as in Kolb's Gem type, etc.

The name Sweet Heart, which has been selected to designate the type, is the name of a well-known variety, generally recognized and highly prized. Figure 3 gives an illustration of three varieties belonging to this type which is also designated in the accompanying diagram :

Sweet Heart Type (oval shape)	light seed	Light Icing.
	dark seed	Sweet Heart. White Gem.

Monarch Type

This type of watermelon resembles the Sweet Heart type in every way excepting shape of the fruit, which is long. The name, Monarch, as selected to designate the type, is taken from the compound name Gray Monarch, the well-known and highly prized watermelon. Figure 3 contains an illustration of two varieties of this type which are also given in the following diagram :

Monarch Type (long shape)	light seed	Gray Monarch.
	dark seed	Seminole.

Icing Type

This type of watermelon is characterized by its very uniform medium green color and its round or oval shape. It differs only in color from the Sweet Heart type. The name, Icing, which has been selected to represent the type is significant on account of the old variety that the term suggests.

Figure 4 illustrates five varieties of this type and figure 5 three more. The following diagram contains those varieties we have tested :

Icing Type (oval shape)	light seed	Dark Icing, Fordhook Early, Ice Cream, Peerless, Green and Gold*, Jones' Jumbo, Ruby Gold,*
	dark seed	Hungarian Honey.

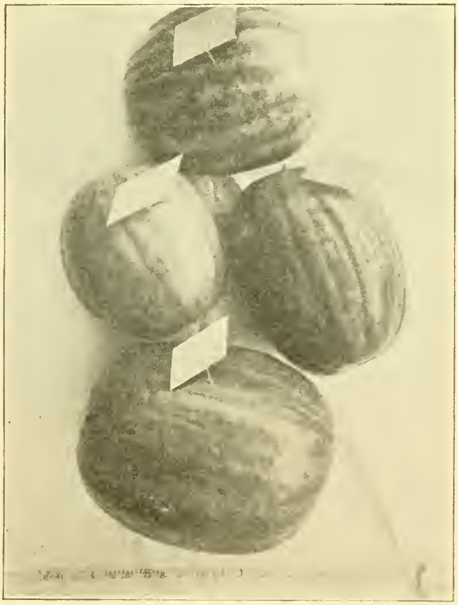

FIG. 11.—Dull Striped Watermelons.
Triumph.
Pride of Georgia. Christmas.
Black Boulder.

Jackson Type

This type of watermelon resembles the Icing type in every particular except shape of the fruit, which is long. The name Jackson is borrowed from the variety already well known. Figure 5 contains one variety of this type and figure 14 the other, both of which are also given in the following diagram :

Jackson Type (long shape)	light seed	Jackson.
	dark seed	Sweet Siberian.*

Black Spanish Type

This type of watermelon is characterized by its very uniform dark green or black color, and particularly its round or oval shape. This type is to the dark green melons exactly what the Sweet Heart type is to the light green class or the Icing type to the medium green class.

Black Spanish is given as the typical name on account of the well known variety of that name which it is thought will convey the idea of classification. Figure 6 contains two varieties of this type, figure 11 one, and also figure 14 contains the Early Corona, a new introduction of the past season.

Black Spanish Type (oval shape)	light seed	
	dark seed	Black Spanish, Cannon Ball, Early Corona, Black Boulder.

Boss Type

The Boss type resembles those of the Black Spanish in every way excepting shape of the fruit, which is long. The name Boss is borrowed from the standard variety of that name. Figure 6 shows three varieties, and figure 5 one of this type. They are also indicated in the following diagram :

Boss Type (long shape)	light seed	Kleckley Sweets.
	dark seed	Boss, Mountain Sweet, Vick's Early.

Kolb's Gem Type

This type of melon is characterized by its having pronounced light and dark green stripings, together with a round or oval shape. The Kolb's Gem Type is to the light striped class what the round or oval shaped varieties are to the other classes. The amount of either white or black in the stripings is not taken into consideration, and it will be found that this varies more or less with different varieties; hence it is necessary to know simply the fact that the proper shades of light and black are present. The Kolb's Gem, the variety from which the name for the type is taken, is representative of the type. Figure 7 contains four varieties representing this type, and figure 8 two. One new variety of the past season's in-

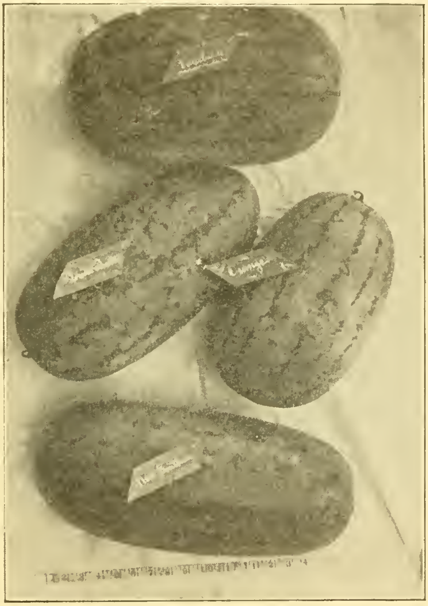

FIG. 12.—Dull Striped Watermelons.

Vauclause.
Florida Favorite. Orange.
New Southern.

troduction, the Golden Gate, also belongs to this type. See figure 14. The following diagram gives the varieties we have grown :

Kolb's Gem Type (oval shape)	light seed	Gragg.*
	dark seed	Kolb's Gem, Mills' Early, Harris' Earliest, Cole's Early, Stokes' Early, Golden Gate, Paul's Bonny Best.

Cuban Queen Type

This type of watermelon resembles the Kolb's Gem type in every way excepting shape of the fruit, which is oblong or medium. The fruit of this class is of quite desirable shape. The variety from which the name of the type is taken is well and favorably known as a good shipper and keeper. Figure 8 contains two varieties belonging to this type, while figure 9 contains one. The varieties grown by us are given in the following diagram :

Cuban Queen Type (medium or oblong shape)	light seed	Delaware.
	dark seed	Cuban Queen, Hoosier King.

Rattlesnake Type

The Rattlesnake type is a long, light and dark striped melon, and herein is the only difference between this type and that of the Kolb's Gem and the Cuban Queen types. The true Rattlesnake variety does not have so much dark green as some of the varieties coming under this head, but the variety is a standard of the type and it is thought on this account the name would easily come into use. The Frontenac variety as shown in the cut is nearly all a dark green but it contains just enough of the light green to designate its identity under this type. Figure 8 contains one variety, figure 9 two varieties, and figure 10 four, all belonging to this type. For names of varieties see the following diagram :

Rattlesnake Type (long shape)	light seed	Rattlesnake, Ironclad, McIvers' Sugar, Santiago, Black Eyed Susan, Dixie.
	dark seed	Frontenac.

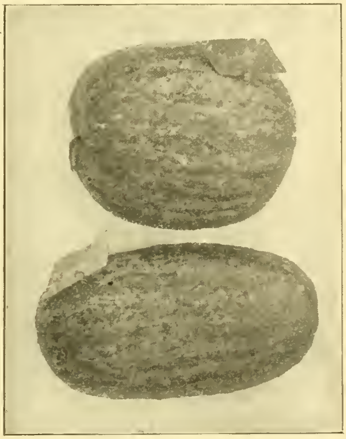

FIG. 13.—Mottled Varieties.
Nabob. Phinney's Early.

Pride of Georgia Type

This type of watermelon is characterized by its dull light and dark stripings. The light stripe, instead of being bright and possessing life, as it were, is a deeper green and rather dead in color. The varieties coming under this head are, therefore, easily distinguished from those of the Kolb's Gem type simply from the standpoint of color of the stripings. They are oval or round in shape. Figure 11 contains two varieties named in the diagram :

Pride of Georgia type (oval shape)	light seed	Pride of Georgia.
	dark seed	Triumph.

Christmas Type

The Christmas type of watermelon resembles the Pride of Georgia type in every particular excepting the shape of the fruit, which is oblong or medium. The Christmas, from which this type takes its name, is a staple variety and seems to have many points of merit. While it is quite dark it nevertheless has well marked dull stripings. Figures 11 and 12 contain one variety each of this type. For names of varieties see diagram:

Christmas type (medium or oblong shape)	light seed	Christmas.
	dark seed	Orange.

Favorite Type

This type of watermelon is a long, dull striped fruit. It differs from both the Pride of Georgia and Christmas types only in shape. Figure 12 illustrates three varieties belonging to this class all of which are indicated in the following diagram:

Favorite type (long form)	light seed	Florida Favorite, Vauclause (red seed).
	dark seed	New Southern, (Cherokee Beauty).

Nabob Type

The characteristics of this type are its mottled or marbled colored green and light fruits together with the oval or round shape. Figure 13 gives the only representative that we have grown of the type:

Nabob type (oval shape) { light seed
dark seed { Nabob.

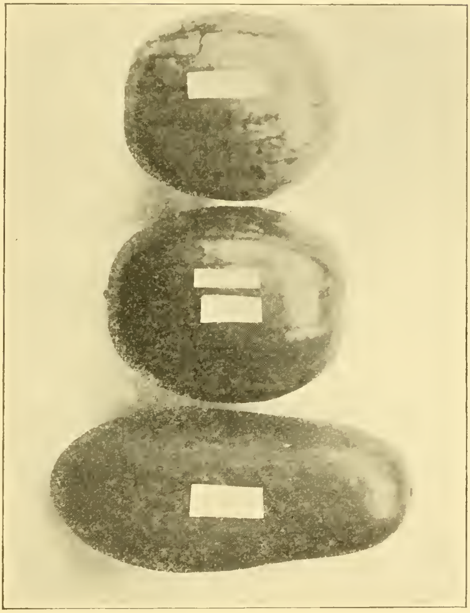

FIG. 14.—Newly Tested Watermelons.
Paul's Bonny Best.
Early Corona.
Jackson.

Phinney Type

This type of watermelon is similar to the Nabob type excepting in shape of the fruit, which is oblong. See Figure 13. We have grown but one representative, as shown in the diagram:

Phinney type (oblong shape)	light seed	Phinney's Early.
	dark seed.	

SUMMARY

1. The watermelon should be grown more generally in the North.

2. It is believed that the great drawback to successful watermelon growing is improper culture. With a better selection of soils and more pains taken in the preparation of the hills it is surprising what a large per cent. of even the Southern varieties will mature here.

3. The best planting dates for Southern New Hampshire have been found to be from May 20th to the 31st.

4. For the preparation of the hills see page 82.

5. One of the worst enemies of the watermelon is the small striped cucumber beetle so commonly found on squashes, cucumbers, etc. For remedy, see page 83.

6. The earlier varieties begin to mature in August. Signs of ripening are discussed under head of picking.

7. A comparative test of varieties is shown on page 85, and a description of each is alphabetically arranged beginning on page 86.

8. The varieties thought to possess special merit for the North, named in so far as possible in order of merit, are: Cole's Early, Boss, Black Eyed Susan†, Peerless†, Kleckley Sweet†, Black Boulder, Black Spanish, Phinney's Early†, Frontenac, Hungarian Honey.

9. The Mills' Early, Harris' Earliest, and Paul's Bonny Best seem to be identical with Cole's Early excepting for average size; these run somewhat smaller. They are equally as early, productive, and desirable. The Stokes' Early may also be associated here, although it has more individuality.

10. A melon weighing between twelve and twenty-five pounds and containing black seeds is generally preferred.

---

† White-seeded varieties.

11. According to the classification of watermelons, were we to select a variety from each class representing their different types, the following would be made:

SHAPE OF FRUIT.	CLASS I Light green.	CLASS II Medium green.	CLASS III Dark green.	CLASS IV Light striped.	CLASS V Dark striped.	CLASS VI Mottled.
Round or oval........	Light Icing.	Peerless.	Black Spanish.	Cole's Early.	Pride of Georgia.	Nabob.
Oblong or medium..	....	....	....	Delaware.	Christmas.	Phinney's Early.
Long..................	Seminole.	Kleckley Sweets.	Boss.	Black Eyed Susan.	Cherokee Peauty.	....

Bulletin 87 November, 1901

NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

THIRTEENTH ANNUAL REPORT

BY CHARLES S. MURKLAND

1866 1893

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

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*Resigned, August, 1901.

THIRTEENTH ANNUAL REPORT

The thirteenth annual report of the New Hampshire College Agricultural Experiment Station, for the year ending October 31, 1901. is hereby respectfully submitted. The reports of the departments will be found upon the pages indicated in the following list:

Financial statement 111
Report of the Vice-Director 113
Department of Horticulture 118
Department of Agriculture 121
Department of Entomology 124
Department of Bacteriology 127
Department of Meteorology 130

Charles S. Murkland,
Acting Director.

ANNUAL STATEMENT

Of the Hatch Fund of the New Hampshire College of Agriculture and the Mechanic Arts, for the year ending June 30, 1900.

Receipts

Cash received from United States treasurer	$15.000.00

Expenditures

Cash paid for salaries	$9,843.57
labor	1.572.83
publications	1,144.13
postage and stationery	73.15
freight and express	69.28
heat, light, and water	989.29

Cash paid for chemical supplies	$45.31
seeds, plants, and sundry supplies	343.28
fertilizers	33.88
library	196.95
tools, implements, and machinery	52.80
furniture and fixtures	4.68
scientific apparatus	47.09
traveling expenses	100.02
contingent expenses	28.46
building and repairs	455.28
	$15,000.00

SUPPLEMENTARY STATEMENT

Receipts

Balance on hand	$54.56
Cash received for analysis of fertilizers, water, etc.	428.80
	$483.36

Expenditures

Cash paid for salaries	$223.94
Scientific apparatus	25.77
Chemical supplies	13.46
Publications	16.00
Labor	23.17
Traveling expenses	2.99
Feeding stuffs	178.03
	$483.36

REPORT OF THE VICE-DIRECTOR

The year has been marked by progress in all lines of station work. Several experiments have been brought to a successful conclusion, some of which have been reported in recent bulletins.

Interest in station publications is steadily increasing, as our mailing-list now requires nearly 11,000 copies to fill it. The requests from other states for our bulletin have been especially numerous during the year, indicating a general appreciation of the station work and of its individuality.

In addition to the regular series of bulletins, there was begun this year the publication of a series of technical bulletins, which contain the results of investigations of value to scientific workers in agriculture ; but are not yet of popular interest. These bulletins are printed in limited editions and will be sent to applicants while the supply lasts.

At the beginning of the last quarter of the year the nearly simultaneous resignations of the agriculturist and associate agriculturist, required the writer to assume temporary charge of the experiments in the agricultural department. The experiments were successfully finished and all data secured ; but the publication of results is necessarily much delayed.

The changes in the station staff during the year were unusually numerous, due in part to the larger incomes of the institutions in the larger states.

C. W. Waid, assistant horticulturist, resigned Feb. 15, to accept a similar position in the Ohio Agricultural Experiment Station.

W. F. Fiske, assistant entomologist, resigned March 9, to accept the position of assistant state entomologist in Georgia.

C. W. Burkett, agriculturist, resigned Aug. 1, to accept the chair of agriculture in the North Carolina Agricultural and Mechanical College.

Marion Imes, assistant in animal husbandry, resigned Aug. 3, to accept an appointment in the Bureau of Animal Industry, U. S. Department of Agriculture.

F. S. Johnston, associate agriculturist, resigned Aug. 20, to accept a similar position in Purdue University, Indiana.

D. B. Bartlett, assistant biologist, resigned Sept. 1 and is now an instructor in the State Normal School.

H. P. Richardson, assistant agriculturist, resigned Sept. 15, and is now in charge of the poultry department at the North Carolina Agricultural and Mechanical College.

H. F. Hall was appointed assistant horticulturist, April 1.

A. F. Conradi was appointed assistant entomologist July 1.

Alexander Williams was appointed herdsman, Aug. 20.

The bulletins issued during the year are:

No. 80. Inspection of Fertilizers in 1900, by Fred W. Morse.

No. 81. The Insect Record for 1900, by Clarence M. Weed.

No. 82. Feeding Farm Horses, by Charles Wm. Burkett.

No. 83. The Value of Meadow Muck, by Fred W. Morse.

No. 84. Forcing Dwarf Tomatoes, by Frank Wm. Rane.

No. 85. Remedies for the Cankerworm, by Clarence M. Weed.

No. 86. Part I. Growing Watermelons in the North. Part II. Classification of Watermelons, by Frank Wm. Rane.

No. 87. Thirteenth Annual Report.

Technical Bulletin, No. 1.

An Annotated Catalogue of the Butterflies of New Hampshire, by Wm. F. Fiske.

Technical Bulletin, No. 2.

Classification of American Muskmelons, by Frank Wm. Rane.

Technical Bulletin, No. 3.

The Food of the Myrtle Warbler, by Clarence M. Weed and Ned Dearborn.

DEPARTMENT OF CHEMISTRY

The department of chemistry has confined its investigation work to the subjects of silage and apples. The former line has been concluded and the results will be prepared for publication during the ensuing year. Some work was also done for the department of agriculture in connection with its manure experiments and soil-moisture determinations, while during the last quarter of the year the writer's whole time was taken up with that department's field experiments.

One hundred and six brands of fertilizers have been analyzed in the annual fertilizer inspection for the Board of Agriculture, and the results will be issued in a bulletin early next year.

An unusually large amount of work has been called for by the general public this year, amounting to eighty-nine different samples of a variety of substances. Some of the results of these examinations are published here, while most of them are of little general interest when considered singly; but become of use as similar analyses are made from year to year.

The testing of milch cows for both the Ayrshire and the Holstein Breeders' associations has involved considerable time and many analyses. In this work, the department of chemistry has been assisted in the fat determination by the creamery.

Just before the close of the year, in the latter part of October, an application was received from Newfields, to have the death of a cow investigated. The animal had apparently eaten something in the pasture which caused her death in a little over forty-eight hours. Dr. Lamson made an examination of the body and of the pasture the day after the cow died. The post-mortem appearance indicated poisoning by an alkaloid like strychnine, and the pasture was found to contain water-hemlock, a plant which contains the poisonous base coniine that produces post-mortem results similar to strychnine. An examination of different organs was carried through with the purpose of determining the presence or absence of coniine. Portions of the contents of the first and third stomachs, a large part of the third stomach, the fourth stomach, contents of fourth stomach and cæcum, the kidney, and a large piece of liver were all examined by the usual method. The parts of the organs were run through a meat-cutter which very quickly reduced them to a finely divided condition for extraction.

Traces of coniine were found in all the extracts; but nothing more than that. The liver, kidney, and fourth stomach gave characteristic odors both of mice and butyric acid. The other extracts gave faint mouse-like odors, but nothing more. No crystals could be separated, neither could any color test or precipitate be produced.

Nevertheless, taking into account the presence of the water hemlock in the pasture, the length of time intervening between the appearance of symptoms and death, the post-mortem appearance and the fresh condition of the organs, there was no hesitation in pronouncing the death due to coniine.

Water analysis has continued to be an important part of our work for the public, although a fee is charged for it. As it is over three years since Bulletin 53, "The Farm Water Supply," was published, some typical analyses are here published to again emphasize the fact that our unpolluted wells and springs yield water that is unsurpassed for purity and quality. Almost nowhere else in the world can ground waters be found which contain so small quantities of soluble mineral matter, and but little care and expense are needed to insure every farm an abundance of healthful water.

Typical Analyses of Drinking Water.

Parts in 100.000.

	Unpolluted spring.	Deep drilled well.	Fairly good well.	Bad well.
Free ammonia	.0008	.0140	.0014	.0030
Albuminoid ammonia	.0029	.0095	.0052	.0152
Chlorine	.40	.50	1.20	7.50
Nitrogen as nitrites	0000	.0001	.0002	.0002
Nitrogen as nitrates	0000	0000	.5000	.5000
Residue after evaporation	4.20	7.40	22.60	37.60

The unpolluted spring was located in Rollinsford near tidewater—and not less than one half mile from any dwelling or source of pollution. The soil was a light sandy loam, forming an excellent natural filter bed, and springs were numerous in the locality.

The deep well was in Rochester and was drilled through 250 feet of solid ledge. The total depth was 300 feet and the well yielded water at the rate of 50 gallons per minute.

The remaining wells were both situated in Durham. The fairly good one is in the midst of a highly-fertilized lawn, surrounded by dwellings, but none nearer than 150 feet. It shows a marked increase in soluble mineral matter, including chlorides and nitrates, probably due to drainage from the lawn. The bad well is within fifty feet of sink drain and vault with their accompanying wastes, and shows very high chlorine and also the presence of too much soluble organic matter containing albuminoid ammonia.

Such wells are too common in our state, when it is possible to secure water like that shown in the first two columns.

A few samples of muck were received from different sections of the state, the analyses of which are given in the following table:

COMPOSITION OF MEADOW MUCK

Parts in 100.

LOCALITY.	Wet Muck.			Dry Matter.	
	Water.	Organic matter.	Nitrogen.	Organic matter.	Nitrogen.
Nashua	79.80	17.90	.25	88.65	1.26
Woodsville	75.39	10.38	.33	42.22	1.38
Orford	93.40	5.37	.10	81.41	1.49
Warren	73.98	20.97	.33	80.61	1.25
Plainfield	62.12	32.13	.53	84.96	1.40
Plainfield	82.85	15.53	.26	90.53	1.53
Spofford	80.57	14.65	.46	75.38	2.38

All but one of these mucks are inferior to the average muck described in Bulletin 83.

It is often the case that a muck is composed largely of clay, while it appears to be black, decomposed vegetable matter.

While muck is a valuable adjunct to stable manure, there is little doubt but that a bog would produce best results by being well drained and then fertilized with phosphoric acid, potash, and lime.

Fred W. Morse,
Vice-Director and Chemist.

DEPARTMENT OF HORTICULTURE

During the year the department practically concluded its work with the muskmelon, which has run over several years, reports having been published from time to time. The culmination of this work was the publishing of Technical Bulletin, No. 2, March, 1901, "The Classification of American Muskmelons." A supplement folder containing the illustrated matter was also issued at the same time and distributed among growers and commission men handling these fruits.

The experiments to determine the effect of artificial light upon plant growth through the use of the acetylene light have also been concluded and will be reported upon later.

Bulletin 84, September, 1901, "Forcing Dwarf Tomatoes under Glass," concluded the greenhouse work in this line that has been carried on for the past few years. It is believed the results from this experiment will be commonly utilized by greenhouse men, who force tomatoes under glass.

Bulletin 86, November, 1901, Part I, "Growing Watermelons in the North," and Part II, "Classification of Watermelons," is the result of a continued study and adaptation of this fruit to our conditions. As therein stated it is believed that the great drawback to successful watermelon growing generally is improper culture. With a better selection of soils and more pains taken in the preparation of the hills, it is surprising what a large per cent. of even the Southern varieties will mature here.

The scheme of classification of the various varieties of watermelons under Part II is original, and the first attempt we are aware of in that direction.

Mr. C. W. Waid. assistant for the past two years, resigned to go to the Ohio Experiment Station on the 15th of last February, and Mr. Harry F. Hall, of Gonic, N. H., was secured to fill the vacancy on March 15th.

More work in the way of improvements has been done, and more area has been successfully handled the past year than heretofore.

Considerable attention has been given to the study of forestry conditions by the head of the department during the year. At the request of private parties, and at their expense, one hundred thousand small pine trees were purchased of Western nurserymen and set out in Cheshire county. A quantity of chestnut and pine seeds has been planted at this same place. About a barrel and a half of black walnuts have been planted on the college farm together with smaller amounts of other tree seeds.

The United States forester has kindly sent us special experts from that department at two different times during the year. They have examined our college forest and suggested methods of management, submittted one report, and have a second under consideration.

A number of shrubs, propagations of our own, were set out about the buildings last spring, and the usual amount of bedding, care of lawns, and so forth, as far as funds for labor would allow, were carried out as usual.

The barn west of the Experiment Station, which was turned over to this department, is being repaired, and the convenience of having the tools, vehicles, and general utensils, as plant stakes, cold-frame sash, vegetable and fruit packages, plant boxes, etc., all in a central place with some one responsible for them, will facilitate matters.

Taking everything into consideration the past season as regards horticultural work was a prosperous one throughout the state, and likewise in this department. The season was a peculiar one in many respects. Early vegetables were backward and did not return what might be termed average yields. However, prices were correspondingly high, so that the cash returns after all were very satisfactory. Early tomatoes, potatoes, cabbage, cauliflower, cucumbers, etc., brought twice or three times as much as on average seasons. From experience and observation it is believed that we would do well in New Hampshire to cater more to an early market. While the past season may be said to be exceptional, these conditions occur frequently and, ordinarily, prices are good at this time of the year. The selection of light friable soils, and the use of plenty of stable manures, go very far toward success with vegetables for earliness. Early varieties must not be lost sight of in our climate. By experimenting simply with the newly introduced varieties here at the Experiment Station we found some quite marked results. The new tomato, Earliana, was extremely early, and as most of the fruit sold at three dollars per bushel, it was a pronounced success. A marked improvement was noted in the newly introduced garden peas, some of the new wrinkled and sweet varieties maturing with the former flavorless kinds. These will be reported upon more fully later. Our work of testing newly introduced vegetables has been continued as heretofore.

During the midseason our nights were relatively cool, so much so that the climatic conditions for warmth-loving plants, especially the cucurbits, as melons, cucumbers, etc., caused much mildewing. This fact taken together with the insect ravages, which were extremely troublesome also on these plants, has had a discouraging effect among growers who specialize with these crops. Spraying for the mildew was beneficial where attempted, but many did not apply the Bordeaux mixture until too late. We noted quite marked results from sprayed cucumber vines. Muskmelons sold at very high prices and were largely imported.

The apple crop was very light generally, it being the off year. Pears were a fair crop, peaches light, with a good crop of plums. The plums rotted badly, but where secured brought good returns. The Burbank and Abundance plums, both Japanese varieties, again proved their great value as fruits worth planting in the state. While some rotted they nevertheless were much less affected than the ordinary domestic sorts. Also from observation we are convinced that they are far less susceptible to injury from the sting of curculio than other sorts. Grapes again yielded well. Small fruits were plentiful. Cherries were generally scarce. One thing that seems strange is that the black-cap raspberries are not more commonly cultivated in many sections. Where raised they seem to be in demand at good prices. The large sized gooseberries bring a better price, and it is questionable whether the Downing and Houghton will be grown so commonly in the future. The three varieties of red currants that are proving best at the station are Wilder, Cherry, and Fay. The black, or English, are a more promising crop than we had thought. A few crates sent to Boston netted us about 10 cents per quart.

The best showing that the writer saw of large or orchard fruits in the state, this season, were the exhibits at the Claremont fair, and that of the State Horticultural Society, held also at Claremont.

FRANK WM. RANE,
Horticulturist.

DEPARTMENT OF AGRICULTURE

Owing to the resignations of the agriculturist and associate agriculturist in August, the completion of the season's experiments was left to the vice director. The work of the department has been mainly a continuation of the experiments in methods of tillage and methods of applications of stable manure begun in previous years. These experiments may now be considered as completed, and a large amount of data on yields of corn and hay, together with soil moisture results, awaits arrangement for publication.

Coöperative experiments with the United States Department of Agriculture were begun in the spring, and included two distinct lines of work:

First, the reclamation of worn-out grass land, in which the station has the assistance of eight farmers in different parts of the state;

Second, the comparison of the vitality of different lots of clover seed grown in different parts of our country and in other countries. Both of these experiments will continue through the coming year.

A series of dynamometer tests with different farm implements was planned, and a number of trials were made in the winter and spring.

The results of these tests, as conducted by Profs. C. W. Burkett and F. S. Johnston, are given in the following notes, prepared by Professor Johnston just prior to his departure:

DYNAMOMETER TESTS WITH FARM IMPLEMENTS

PLOWS

In making the tests with plows only those plows which are in general use in New Hampshire were used. This test is interesting as an illustration of the comparative effectiveness of the old and modern types of walking plows. Only two types were available for the trial, but these were characteristic.

Only one set of trials has thus far been conducted, and the results, while definite, should have a somewhat further demonstration. It will be noted in the table following that the Yankee plow required a much greater power to do the same amount of work under conditions which were as nearly alike as it is possible to make them:

Implement.	Trial Conditions.	Draft.
Plow.	Soil, clay loam.	
Yankee.	Furrow slice 13 in. wide by 8 in. deep.	676.3
Hussey.	Furrow slice 13 in. wide by 8 in. deep.	398.4

HARROWS

In the following trials with the disc harrow it should be noted that the soil was a clay loam, which had been in sod until shortly before the tests were made. The conditions under which the tests were made were very similar to what would be expected on the average New England farm. It will also be noted that the trials were made under four different conditions of the implements, viz., one with the discs set as far forward as possible, one with the discs set at a medium angle, one with the discs set at the ordinary angle, somewhat away from the straight line, and a fourth condition where the discs were set in a straight line. The tests were made both on grade and on level, and although the series is not complete, yet the results are thought to be of considerable value.

The following table shows the conditions of the trial and the number of pounds of draft under each condition:

IMPLEMENT.	TRIAL CONDITIONS.	DRAFT.
Harrow.		
Disc.	Set at full angle, up grade, 1 to 8, man riding.	676.2
	Set at full angle, up grade, 1 to 8, no load.	555.4
	Set at full angle, down grade, 1 to 8, man riding.	555.4
	Set at full angle, level, man riding.	618.3
	Set at medium angle, up grade, 1 to 8, no load.	398.0
	Set at medium angle, down grade, 1 to 8, no load.	386.4
	Set at medium angle, level, man riding.	410.5
	Set at ordinary angle, down grade, 1 to 8, man riding.	483.0
	Set at ordinary angle, down grade, 1 to 8, no load.	386.4
	Set at straight angle, up grade, 1 to 8, man riding.	350.0
	Set at straight angle, down grade, 1 to 8, man riding.	241.5
	Set at straight angle, up grade, 1 to 8, no load.	298.8
	Set at straight angle, down grade, 1 to 8, no load.	217.4
	Set at straight angle, level, man riding.	313.9
	Set at straight angle, level, no load.	265.6

In conducting a trial to determine the draft of a spring tooth harrow it is important to keep in mind the fact that the actual draft in pounds does not indicate all the power used by this implement. The tendency to unsteady motion dissipates a considerable amount of the force required for actual operation. The results in our trials with the spring tooth harrow are pretty nearly what would ordinarily be expected when comparing the implement with other harrows. In the table following the results are given under three conditions of draft:

IMPLEMENT.	TRIAL CONDITIONS.	DRAFT.
Harrow.		
Spring tooth.	Set ordinary, operated on level, man riding.	627.9
	Set ordinary, operated on level, no load.	531.3
	Set ordinary, operated up grade, no load.	555.4

CORN BINDERS

Several trials having for their object the testing of the relative efficiency of different types of corn binders have been planned, and the results here given are only a beginning. The draft in this farm implement is a most important consideration. Their weight has a large effect in their draft, owing, of course, to the fact that a corn field is usually in a high state of cultivation and readily allows the wheels to sink low into the soil. Then, too, the widely varying size of the stalks and resulting varying in weight of the corn itself all tend to make the conditions surrounding a test of this nature variable. The following table will serve to illustrate something of the effect of heavy and light corn on the binder:

Implement.	Trial Conditions.	Draft.
Corn binder.	Heavy corn, clay land, soil dry and mellow.	567.5
	Light corn, clay land, soil dry and mellow.	301.6

FARM VEHICLES

In the trials with farm vehicles there were made use of a four-inch tire farm wagon, a two-horse farm cart, a farmers' handy wagon, and a pair of bobsleds. The test was one whose primary object was to determine the comparative draft of these vehicles under varying conditions. As a result of such a trial much information could be obtained in the matter of comparison between broad and medium tired wagons. Also some data concerning sliding and rolling friction as affecting the draft of farm implements and vehicles could be gathered. It might also be pointed out that a trial of this nature has much to do with showing the relative advantage of loading near the source of power rather than at a distance, and also as to the matter of placing the load on the line of draft or above or below it. The following table is a summary of the work along this line done at this station:

Vehicle.	Trial Conditions.	Draft.
4-in. tire wagon.	Up grade 1 to 30, snow 6 in. deep, load 1,000 lbs.	434.7
	Level, meadow stubble, load 1,000 lbs.	265.6
	Level, slightly muddy, load 1,000 lbs.	241.5
Farm cart.	Up grade 1 to 30, snow 6 in. deep, load 1,000 lbs.	821.1
	Level, slightly muddy, load 1,000 lbs.	352.5
Farmers' handy wagon.	Level, meadow stubble, load 1,000 lbs.	313.9
Bobsleds.	Up grade 1 to 30, snow 6 in. deep, load 1,000 lbs.	144.9
	Up grade 1 to 30, muddy, load 1,000 lbs.	724.5
	Up grade 1 to 30, slushy, load 1,000 lbs.	338.1
	Level, snow, load 1,000 lbs.	135.2

DEPARTMENT OF ENTOMOLOGY

The work of this department during the year has continued along the lines of previous years, although it was seriously interrupted by the lack of an assistant during the important months of April, May, and June. In March Mr. W. F. Fiske, who has rendered efficient assistance for several years, resigned to become assistant state entomologist of Georgia, and his successor, Mr.

Albert F. Conradi, B. S., a graduate of the Ohio State University, did not begin work until July, since when he has helped greatly in the efficiency of the department. During the spring months my own time was so filled with teaching and other college duties that extended observations in the field and laboratory were out of the question. Consequently it was impossible to follow as closely as I desired some notable insect outbreaks—particularly those of the cankerworm and the apple-leaf hopper.

Four bulletins, covering 114 pages of printed matter, have been issued by the department during the year. Two of these—Bulletin 81, "The Insect Record for 1900," and Bulletin 85, "Remedies for the Cankerworm," were in the general series, and two—"The Butterflies of New Hampshire," by Mr. Fiske, and "The Food of the Myrtle Warbler," by Dr. Ned Dearborn and myself—were in the limited technical series, designed primarily for distribution among specialists.

The principal lines of work of the department for the year may be summarized as follows:

1. Studies of remedies for the cankerworm.

2. An extended study of the squash bug—its life history, enemies, and methods of preventing its injuries. The results are to be published in a bulletin now nearly ready for printing.

3. A continuation of experiments with combinations of kerosene and water as an insecticide.

4. A continuation of our studies of the food of birds, in which I have had the volunteer assistance of Dr. Ned Dearborn.

5. The preparation of a bibliography of birds in their relations to agriculture.

6. The preparation of an extended article upon the parasites of the tent caterpillar, based on the observations of Mr. Fiske for the last five years. This will be an important contribution to our knowledge of the effect of parasites upon crop pests, and I hope to be able to publish it as a technical bulletin at an early date.

7. The commencement of an investigation of the mosquitoes of New Hampshire, with special reference to the practicability of destroying them in our summer resort regions.

8. Miscellaneous observations upon injurious insects, and correspondence in reference to them, a fuller account of which will appear in the Insect Record for 1901.

9. Additions to our collection of New Hampshire insects, made also with a view of mapping the faunal areas of the state.

10. Photographs of many insects and the injuries they produce.

In addition to these lines of work, which may properly be classed under the head of investigations, I have devoted considerable time to the movement for the introduction of nature study into our schools. There is no need for arguing here the statement that in no way can the agricultural conditions of the state in the future be more surely improved than by getting the children of our schools interested in the study of the natural history of their vicinities. For this statement has received the endorsement of practically all the leaders of educational thought, and forms the basis of much excellent work by several of our most progressive stations. In October, 1900, I was appointed, by the state educational council, chairman of a committee to outline a course in nature study for the schools of New Hampshire. Such a course was presented to the council in September, 1901, and recommended by the council to the State Teachers' association, by which it was adopted at the annual meeting in October. This course, which was largely prepared by other members of the committee—Miss Lilly P. Shepard of Nashua, and Mr. James H. Johnson of Bradford—will form a working basis for the nature study in our schools for years to come. It is quite complete for the lower grades, but for the upper grades more extended outlines of certain special topics are needed, and I earnestly hope that the Station will be able to publish occasionally for distribution to the teachers of the state a nature study leaflet in which these topics are discussed. In addition to the work upon this outline, I have, on the invitation of the state superintendent of public instruction, discussed various phases of nature study at several teachers' institutes, and had charge of the instruction upon this subject at the state summer institute at Plymouth.

The department is greatly in need of more entomological and ornithological books, especially the earlier volumes of various series of Transactions of Societies, as well as of more insect cases for the arrangement and display of our collections.

CLARENCE M. WEED,
Entomologist.

DEPARTMENT OF BACTERIOLOGY

The work of this department during 1901 was directed to the study and treatment of fungous diseases of plants, storage of apples, bacteriology of ensilage, and the study of weeds.

NOTES ON FUNGOUS DISEASES

The season of 1901 seemed to be very favorable to the development of these diseases. Most of the familiar ones—such as apple leaf and fruit spots, pear scab, black knot, tomato rot, early and late blight of potatoes—were present in at least their average abundance. Several seemed to be more abundant than usual. Of these the following have not been specially considered in previous bulletins of this Station:

Peach Leaf Curl.—This is a disease which attacks the leaves, twigs, flowers, and fruit of the peach. It takes its name from the characteristic appearance of the affected leaves. These become strongly wrinkled or puckered, owing to the unusual development of the cells of certain areas caused by the presence of the vegetative part of a fungus. Later the wrinkled surface takes on a whitish or frosted appearance, due to the development of the fruiting or spore-bearing part of the fungus. The leaves turn yellow and soon drop off. Diseased twigs become swollen and distorted; diseased fruits drop off. The losses caused by this disease are oftentimes very serious; but it appears that they may be largely prevented by suitable treatment. According to a recent bulletin of the Division of Vegetable Pathology of the United States Department of Agriculture, the chief source of infection in case of this disease is the spores which germinate in the spring and attack the first tender growth from the opening buds. The treatment recommended and which has proved very successful, is a thorough spraying of the trees with Bordeaux mixture a short time previous (two weeks) to the opening of the buds.

Plum Rot.—This disease attacks the fruit at, or a short time previous to, the period of ripening. Its first appearance is as a brown spot, which rapidly spreads until the whole plum is involved. Upon the brown surface there soon appears an abundant grayish mold growing in little cushion-like masses or tufts. Examined under the microscope these tufts are found to consist of chains of oval spores produced in countless numbers. The spores are ready to germinate at once and infect other plums. This takes place by contact, owing to the thick clustering of the fruit, or by wind-carried spores. Possessed of such abundant means of reproduction, and occurring at a time when the weather conditions are especially favorable to the development of fungi in general, this disease spreads with great rapidity, and does a large amount of damage. Once started it is a difficult disease to remedy.

Spring infection is believed to come chiefly from the diseased plums of the previous year which fall to the ground or may remain on the tree. Hence one of the most important measures of treatment is the destruction of all diseased plums as soon as possible. These should be gathered and burned or securely buried. The trees should be disinfected by a thorough spraying with Bordeaux mixture before the buds open; a second spraying should be given soon after the fruit has set. As ripening time approaches the spraying should be repeated at intervals of a week or ten days, using the solution of copper carbonate instead of Bordeaux to avoid staining the fruit.

Peach Rot.—The peach is affected by the same disease as the plum, and may be treated in the same way.

Downy Mildew of the Grape.—This disease developed to an unusual extent in the Station vineyard during the season of 1901. There are numerous species of downy mildew which attack different cultivated plants; they are characterized by the production of whitish downy or mold-like patches on the affected part. The "mold" consists of the fruiting part—spores and spore stalks—of the fungus which is growing in the deeper tissues. The downy mildew of the grape appears first as yellow spots on the leaves, which soon develop on their under surface the characteristic downy growth. The diseased leaves die and drop off. This disease also attacks the stems and fruit on which it produces brown spots which later become grayish from the development of the spores and spore stalks, hence the disease when affecting the fruit is spoken of as the brown or gray rot. The treatment which has been found successful consists in spraying with Bordeaux mixture just before the blossoms open, again after the fruit has set, and a third time a fortnight later. Our experiments indicate that the earlier sprayings are especially desirable.

Another disease, sometimes very destructive to the grape, was observed in a large vineyard in the southern part of the state; this was the *black rot.* This affects both the leaves and the fruit, but more especially the latter. The grapes turn brown and finally black, become dry and shriveled with sharp angular ridges and roughened with minute pimples which contain the spores. This disease. as far as our observation goes, is not so likely to do serious damage in New Hampshire as in other grape-growing localities. It may be successfully treated by spraying with Bordeaux mixture before the buds open, again before flower buds open, again after fruit has set, a fourth time two weeks later.

Downy Mildew of the Cucumber and Muskmelon.—The cucumber crop in some localities in this section was almost a complete failure. Just after the vines had reached a productive stage they rapidly took on a diseased appearance and soon died. The trouble was caused by a fungus similar to one of the above mentioned grape diseases, viz., a downy mildew. At the outset of the disease in the cucumber, yellowish spots appear on the leaves; these mark the points where the mycelium of the fungus is developing in the tissues of the leaf. After this has reached a certain stage the spore-bearing branches are developed and push their way out through the epidermis of the leaf, forming the mold-like patches on the under side. The whole leaf turns yellow, dies and becomes brown and dry. Soon after the disease was noticed in the Station garden, the cucumbers were sprayed with Bordeaux mixture, but with little if any good effect. This is not surprising, for we know that in case of many of the fungous diseases, perhaps in case of most, after the disease has reached a stage when it becomes noticeable, it is too late to remedy it. Hence it is of the greatest importance to know in case of each disease when infection is likely to take place, in order that it may be forestalled. The cucumber mildew usually makes its appearance sometime in August. The vines should be sprayed with Bordeaux mixture by the last of July, and the spraying repeated two or three times at intervals of about ten days.

The muskmelon crop also suffered from the attacks of the downy mildew. What has been said above in regard to the disease in the cucumber is equally applicable to the muskmelon.

Apple Tree Canker.—A disease known as apple tree canker has during the past two or three years been attracting the attention of students of plant diseases. We desire to get an idea of its prevalence in New Hampshire. To that end we urge apple growers to note its presence or absence in their orchards.

The canker usually presents the following characters: It attacks limbs of one to three or more inches in diameter; the diseased part may be from a few inches to two or more feet in extent, is usually more or less swollen, its surface is covered with roughened or cracked bark darker in color than normal. The disease is believed to be caused by a fungus. We have at present no remedy to recommend.

H. H. Lamson,
Bacteriologist.

DEPARTMENT OF METEOROLOGY

Observations for the year July 1, 1900, to July 1, 1901, have been continued as usual and have been under the immediate charge of E. P. Jewett, New Hampshire College, class of 1901, as observer.

Signal flags, indicative of the weather for the succeeding night and day, have been displayed from the tower of the Experiment Station building, from 11 a. m. until sunset each day except Sundays and holidays throughout the year.

The humidity of the atmosphere has been determined, through the growing season only, by readings of the wet-bulb thermometer.

The summary gives interesting comparisons of temperature, precipitation, cloudiness, and prevailing wind direction, together with averages covering the past six years. The mean temperature for the year, as determined from the average of 8 a. m. and 8 p. m. observations, was 46.5 degrees Fahrenheit or six tenths of a degree higher than the average for six years. The mean as obtained from the maximum and minimum readings was 46.6 or seven tenths of a degree higher still. This high mean was due to an unusual succession of five warm months, commencing with July, culminating with October, and ending with November. It would have been still more accentuated but for an unusually cold February which averaged 4.4 degrees below the mean for six years. The remaining months varied only normally from the mean. It is worthy of record that, while February averaged so cold, there was only one day during the month when the minimum thermometer registered below zero. While the remaining winter months averaged about as usual, there was likewise noted an absence of extreme temperatures. Only twice did the minimum register below zero in January and not at all in either December or March.

The summer months of 1900 were slightly warmer than usual but no remarkable heat spells are recorded. While July was the warmest month, as was to be expected judging by previous averages, the most depressing hot spells and the highest maximum temperature occurred in August. September, October, and November were uniformly warm for the season. No killing frost occurred until October 18 and not even a light one until September 20.

Perhaps the most unusual phenomenon of the year was the passage of a destructive tornado across the central portion of the town of Durham, N. H., about 4 : 45 p. m. on November 21. The tornado passed very nearly from west to east across the town, the destructive area being only a few rods in width and extending intermittently for about two miles. Two barns of strong construction were unroofed and otherwise damaged ; chimneys were demolished and large trees prostrated.

The total precipitation for the past year has been somewhat less than usual, the driest month being June with only .35 inch of rainfall. However, the extensive rains of March, April, and May, though following an open winter which had been particularly trying to the grass roots, insured an excellent hay crop. The rainfall for April was the heaviest of the year. It is interesting to note that, on the average, November and March have been the months of heaviest, and June and December of least, rainfall during the past six years. The difference is apparently sufficient to indicate a more or less permanent tendency, at least with reference to certain seasons.

The snowfall was deficient during the whole winter, and there was comparatively little good sleighing.

While the observations of wind direction are rather unsatisfactory, they show a decided average from a westerly quarter.

C. H. Pettee,
Meteorologist.

METEOROLOGICAL SUMMARY.

	Average temperature.*		Precipitation.		Snow in inches.		No. days .01 inch precipitation.		1900-1901.			
	July 1, 1895, to July 1, 1901.	1900-1901.	Average, July 1, 1895, to July 1, 1901.	1900-1901.	Average, July 1, 1895, to July 1, 1901.	1900-1901.	Average, July 1, 1895, to July 1, 1901.	1900-1901.	Prevailing wind direction.	Days clear.	Days partly cloudy.	Days cloudy.
July	69.4	72.0	3.56	1.50	....	....	9	8	W.	4	22	5
August	66.9	68.2	3.08	2.49	....	....	9	9	S.	5	17	9
September	59.0	61.0	4.19	3.30	....	....	8	9	S.	15	10	5
October	47.9	52.0	3.59	4.32	....	....	8	10	N. W.	13	6	12
November	37.3	39.3	4.96	5.04	5.21	2.75	10	9	W.	12	6	12
December	26.4	25.5	2.94	3.83	5.2	4.00	7	4	N. W.	11	12	8
January	20.8	20.5	3.93	1.82	19.15	13.25	6	7	N. W.	13	8	10
February	22.1	17.7	3.95	.79	14.4	9.50	7	2	N. W.	16	7	5
March	30.3	31.6	4.81	5.38	12.5	5.50	9	10	N. W.	7	10	14
April	43.8	43.6	3.37	7.94	1.16	....	9	15	N. E.	8	3	19
May	54.6	52.8	3.14	4.27	....	....	9	8	S. E.	11	7	13
June	64.6	66.3	2.84	.35	....	....	9	7	S.	20	6	4
Sum	513.1	550.5	41.36	41.03	57.65	35	100	98		135	114	116
Mean	45.3	45.9	....	....	....	....	....	....	N. W.			

*Average of 8 a. m. and 8 p. m. observations.

PUBLICATIONS OF EXPERIMENT STATION

The following publications of the Station are available for distribution :

No. 2. Feeding Experiments.
No. 3. When to Cut Corn for Ensilage.
No. 4. The Science and Practice of Stock-Feeding.
No. 5. Fertilizers and Fertilizing Materials.
No. 6. Experiments with Fertilizers.
No. 7. Test of Dairy Apparatus.
No. 8. Feeding Experiments. Part 1. Principles of Feeding. Part 2. Corn Meal, Middlings, Shorts, and Cotton-Seed Compared.
No. 9. Effect of Food upon Milk.
No. 11. Pig Feeding. Part 1. Results of Feeding Skim Milk and Corn Meal versus Corn Meal and Middlings. Part 2. Digestion Experiment.
No. 12. Fertilizer Experiments.
No. 14. Ensilage in Dairy Farming.
No. 16. Effect of Food on Composition of Butter Fat.
No. 17. Stock Feeders' Guide.
No. 18. Effect of Food on Milk.
No. 19. Spraying Apples and Pears against Fungi.
No. 20. Effect of Food on Milk. Feeding with Fats.
No. 21. Farm-yard Manures and Artificial Fertilizers.
No. 22. Prevention of Potato Blight.
No. 23. Some Dangerous Fruit Insects.
No. 24. The Flow of Maple Sap.
No. 25. The Composition of Maple Sap.
No. 26. Analyses of Fertilizers and Wood Ashes.
No. 27. Spraying Experiments in 1894.
No. 28. Remedies for the Horn Fly.
No. 29. Remedies for Flea Beetles.
No. 30. An Experiment in Road Making.
No. 31. Seventh Annual Report. 1895.
No. 32. Studies of Maple Sap.
No. 33. Two Shade-Tree Pests.
No 34. Surface and Sub-Irrigation out of Doors.
No. 35. The Codling Moth and the Apple Maggot.
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